THE CONCEPT OF INDETERMINISM

AND ITS APPLICATIONS

THE CONCEPT OF INDETERMINISM AND ITS APPLICATIONS

Economics, Social Systems, Ethics, Artificial Intelligence, and Aesthetics

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Poem "The Fountain and Wagner" by Ulea. Reprinted with the permission from Ulea

To Russell Ackoff, my dear friend and teacher —

a great scholar whose unusual creativity combines philosophy, art, science, and their practical applications;

a great man whose generosity my family and I experienced on more than one occasion;

in the honor of his 75th birthday —

with an excuse for the delay in the publication of this book.

As the Russian proverb says: "Better late than never!"

Ulea

The Fountain and Wagner

Parchment! Is that the sacred fountain whence alone
There springs a draught that thirst for ever quells?
Goethe, *Faust*

1. *The Fountain*
Once more to etch the fountain
And the moment of freedom
To carry the picture
To the stony Eden—
Under the ancient arches and domes
Of the Empire of scholarly dogmas.

Hi, descendant of Wagner! I entered again
Your monastery of books and the used up papers.
You remember everything. But in vain
Your zealous forehead traces
These flashing spurts. You derive
A formula from anything in your chancellery facilities,
Neglecting the phenomenon of life
That is always a fight of improbabilities.

You split and reconstruct the pulsating water
In accordance with your programmed ideals,
Being yourself the improbability of the supreme order
And a probability of the existing ideas.

2. *Wagner*
Ah, Wagner, Wagner!
Perhaps, you are immortal.
I see the acute roundness
Of your triangular back
Fixed in your chair-stand
While you total
Something that causes
That constant learner's ache.

Your silhouette is sigma-like. In this native
Space your mind comprehends the sigmas.
It assumes that all diversities and negatives
Are the simple sum of the universal completeness.

viii

The bulky safes of volumes, which are in resonance
Of my mobility, preach from a distance
How to keep our natural balance
In that polar coexistence
In which a one-day living butterfly,
No more important than a light illusion,
Will fly in, hurrying to beautify
The world both as its search and solution.

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Naturally, all the above mentioned people bear no responsibility for the material in the book.

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INTRODUCTION

Analysis of systems characterized by relatively fast-paced change has been impaired by the application of methods suitable for systems that feature slower rate of change. More specifically, research into biological, socioeconomic, artificial intelligence, art, linguistics, and other such systems is affected adversely by the use of the methodology more suitable for such extensively explored systems as the physical system.

The investigation of the universe aims to uncover the *laws* that govern the physical processes. This methodology was deemed appropriate because the physical system was perceived as changing very slowly (in time and in space). Once discovered, the law (such as the law of gravity) was thought fixed and universal for the entire physical domain (not just some parts of it) from elementary particles to galaxies.

Apart from the physical laws, the universe was analyzed algorithmically; that is, on the base of equilibrium (optimization) models that incorporate the variables of given physical systems. This complete and consistent procedure links the initial state of a system with its future states.

This raises the following question: What are the specific features regarding fast changing systems that preclude the use of the methodology that is widely adopted in physics

The one distinguishing mark of a changing system is the presence of *two-ended source of development*. I call it *Janus processes* (in my previous writings I called them *tunnel processes*) following the image of the Romans' god Janus. In accordance with the Roman mythology, Janus, as the patron of beginnings and endings, has two faces looking in opposite directions: one in front, the other at the back of his head (*Webster New World Dictionary,* 1980). The features of *Janus processes* require a new methodological approach, which leaves room for the classical methods, but now these methods must be integrated into the new scheme (and new methods) that is adequate for the study of changing systems.

Especially, this new methodological approach is required when one deals with an *incomplete Janus process*. Let me elaborate on this rather odd term. It denotes a process where the changes in the system are triggered both at the *end* and at the *beginning* but the beginnings and the ends are not fixed for ever and the way between them is not complete, that is, it can have gaps. For example, a writer (a poet) in the process of composing may have a final goal, which is best expressed by the term *closure* (Smith, 1968). Guided by this closure, the creator attempts to organize the entire structure of the work. On the other hand, the writer may proceed without having any concrete fixed *a priori* image of the final goal; he finds the *beginnings* and develops them, eventually arriving at the final destination (Said, 1975). This state is not determined by the writer in advance (for example, the author may suffer from the realization of the fact that if he is to follow the admissible behavior of the hero, he/she would be compelled to kill him in the end).

Classical methods are quite adequate in situations where we can start at the end (the final state) and link it to the current state in a complete and consistent manner. By the same token, if extrapolation is admissible, we can start at the beginning (the initial state) and proceed until the system reaches the desired state; if extrapolation law is not known, the process is terminated when the system reaches a state that was, perhaps, not defined ahead of time, but, once reached, signals termination of the procedure.

But how are we to proceed if we start at the beginning, before we reach the desired state (in the example above, killing the hero)? We might have information regarding the feasible space of the system's behavior (in the above example, the admissible behavior of the hero) and the initial conditions. Granted, this case allows us many degrees of freedom, but it confronts us with a very difficult task of how to proceed within this feasible space and, at the same time, satisfy certain ordering constraints?

This is where the new "calculus" of assessing system's dynamics come in; these methods help coordinate and link the various stages of the new procedure.

Our discussion to this point probably appears rather nebulous. Hopefully, the specific topics examined in the book will shed some light on my general conception of the new method.

Before we proceed with the more concrete analysis I would like to make a brief digression into the methodological framework underlying my analysis.

My methodological approach is predicated upon the philosophical category of determinism/indeterminism. My research represents an ambitious attempt to (1) specify this category, (2) link it with such notions as probability, causality, predictability, freedom, and freedom of will, and (3) to begin to quantify the category of indeterminism.

I realize the general academic canon and all the literature on the subject with which one needs to familiarize oneself before tackling such a fundamental issue as indeterminism. However, the vast amount of literature precludes me from exploring it in full in the light of my ideas. I settled upon a compromise: I shall go ahead and express my ideas regarding indeterminism, but I will refer to

some of the literature on the subject, particularly the more recent works, which, I assume, have taken into account the developments in the respective field.

I must confess that I became aware of the book, *A Primer on Determinism* by John Earman (1986), only on the eve of the submission of the camera-ready copy of my manuscript to the publisher. The ideas expressed in this book are very close to my own. Both of us arrive at many similar conclusions using different arguments and methodology. However, the content of my book is very different from Earman's book. The major part of my book is devoted to problems not discussed by Earman—the problems of the degree of indeterminism in different fields. In this framework, I introduced a new phase of indeterminism—predispositions—and a new calculus of its accounting.

Certainly, I have not come anywhere close to resolving the philosophical issues posed in my book, but I do believe I have sown the seeds of a new approach. During the course of my research, my determinism-indeterminism paradigm shifted. I now regard determinism as inevitability, independent of the degree of uncertainty of the outcome. The prospect of "ordering" the process suggests it may be deterministic, since fully ordered processes are always inevitable. However, not every non-ordered process can be finally ordered, and if so, non-order becomes inevitable and the process turns in deterministic.

My next step was to link the concept of indeterminism/determinism with the axiological scheme, underwritten by a new concept entitled spectrum of conditionality of the valuations. In keeping with the general systems theory I want to portray values as isomorphic to a variety of systems ranging from natural to man-made systems (values are generally thought to be the prerogative of the latter). Detailed discussion of these ideas can be found in many of my works (see, for example, Katsenelinboigen, 1984) and certain chapters of this book also touch upon the axiological issues as they pertain to the respective field.

A formal scientific analysis of determinism-indeterminism must be based ultimately on a mathematical representation (not necessarily based on any of the existing mathematical paradigms). Mathematical models proved highly effective in describing deterministic processes. Mathematical procedures devised for the indeterministic domain have come under the guise of *satisficing solutions* (Simon, 1979) and *heuristic programming*. However, I am not familiar with any attempt to construct a general typology of these procedures and certain procedures, notably the *formation of predispositions*, have been omitted altogether. The present book aims to fill this gap.

The concept of determinism-indeterminism has given rise to a typology of decision-making methods applicable to settings (phases) characterized by different degrees of indeterminism. The focus of my research is the indeterministic phase and the *constructive* application of a new method for quantifying the state of a system.

Generally speaking, the proposed method derives from the probabilities-based approach in the "Kolmogorovian" sense of the term (rather than based on observed statistical *frequencies*). This method is predicated upon some very concrete structures, which have become the subject of critical philosophical investigation in the light of Karl Poppers' (1954) concept of *propensities*. I

chose to call this structure *predisposition,* and the respective technique for creating predisposition—the method of *predispositioning*. The new term underscores the distinction between the new procedure and the entrenched notion of probabilities based on observed frequencies. *Constructive* creation of predisposition is a fascinating but poorly explored topic.

Over the course of my work I have discovered that scholars in many different disciplines are exploring, albeit implicitly, similar ideas to combat indeterminism when the conditions prohibit the use of frequency-based probabilities. Many researchers do not realize that, in effect, they are dealing with the same issues. Many seemingly disparate problems dealing with the measurement of system's predisposition lend themselves to the same treatment, including such areas as the evaluation of a chess position, formalized by Claude Shannon (1950) and implemented in many computer programs, Russell Ackoff's (1981) concept of development of social systems via a multistage planning process, the concept of invisible assets and evaluation of performance by Japanese corporations (Itami, 1987), the nonclassical analysis of firm behavior elaborated by Sidney Schoeffler (1991), the index of vulnerability in strategic minerals devised by Alvin King (1981), the measurement of Modern Economic Growth proposed by Simon Kuznets (1966), the concept of balascopy as a tool for heuristic diagnosis developed by Vadim Kvitash (1983), Willem Stemmer idea (1995) to consider biological evolution as a chain of recursive cycles, each of which operates on a limited set of elements and where at each cycle "only the most promising sequences are selected and used as the basis for further mutagenesis and selection", the elaboration of the hypothesis of positional information in biology by Stuart Kauffman (1993), the usage of positional parameters in psychotherapy by Daniel Giacomo and Mona Weissmark (1997), the formation of predispositions in literary works, in particular Leo Tolstoy's *War and Peace* by Saul Morson and Anton Chekhov's plays by Vera Zubarev, the aesthetic measurement of art works elaborated by George Birkhoff (1933), "Algorithmic aesthetics" in computer models for criticism and design in the arts, by George Stiny and James Gips (1978), the heuristic methods of pattern recognition by Alex Petland (*Discover,* 1992), the idea of connectivity in mathematics suggested by Ron Atkin, and so forth. This approach is applicable for the analysis of such subjects as interactions among animals, living cells, the right and left hemispheres of the brain, ecological systems, family and personal problems, certain social movements (notably the dissidents movement in the former Soviet Union, the nonviolence movements in India headed by Mahatma Gandhi and in the village Le Chambon during the World War II headed by André Trocmé, terrorism, Zionism), the evaluation of military positions and martial arts, different kinds of games (*Go,* in particular), interpretation of the epistemology of the creators of the Torah, and, perhaps, even physical objects in the domain of quantum mechanics and general field theory. Many of these subjects have been considered in the papers of my students who have taken my course *An Aesthetic Approach to Decision Making* in the last few years (Katsenelinboigen, 1997*b*).

The complexity of predisposition varies from field to field, ranging from a simple pattern to an artistic image. Exploring different systems, I will elaborate on the extent of complexity of the respective category of predisposition.

Verifiability of the idea of measurement of predispositions ranges from such experimentally verifiable methods as those employed in chess programs to logical speculations concerning new interpretations of old theological questions. The
extent of verifiability of the methods used to measure predispositions oscillates between these two extremes.

Systems that are amenable to formal description of a predisposition merit special attention, if only because they provide an experimental substrate for testing the viability of the proposed theory. Conversely, systems that yield relatively inexact results may contribute to the elaboration of a general theory of predisposition, since these systems may possess features that are lacking (or hidden or insignificant) in other systems.

As an illustration of my approach, compare chess and economics. Of course chess is much less complex than the economic system. For one thing, chess is zero sum game, which is only one mode of interaction (there is win-lose). Moreover, when we confront a unique situation in chess, we can be sure that the known material objects (pieces) are fixed, in the sense that chess rules preclude the introduction of new pieces. The same does not hold true for the economy where unique situations may feature the emergence of new objects (products) or means of manipulating them (technologies).

Still, chess does disclose various methods of operation, notably the creation of predisposition—methods which may be applicable to other, more complex systems. The lack of a unified vision impedes wider use of the concept of predisposition and results in critical mistakes in the applications of this concept.

Considering the novelty and the importance of this avenue of research, I organized a symposium called *Calculus of Predisposition*, held March 26-29, 1992, in Philadelphia and sponsored by the Research Foundation of the University of Pennsylvania. The primary aim of this symposium was to bring together specialists from different branches of arts and sciences and organize a dialogue on the problem of formation and measurement of predisposition.

As a confirmation, consider the list of the participants, their affiliations, and their report topics (shown on the next page).

I realized the chance I am taking in organizing such a gathering—each participant will talk about his/her professional field using his/her professional lingo. But terminology was not the biggest stumbling block in the way of proper communication: there was a big gap in the level of formalization of the material presented, ranging from formal mathematical statements in the reports of Ron Atkin and Jeffrey Johnson, Louis Kauffman to the rather loose, humanities style in Vera Zubarev's talk on *Romeo and Juliet*.

I am a big fan of the Bible, and I hold the book in high esteem. I am well aware of the sad outcome of the endeavor to erect the Tower of Babel after all the languages were intermixed. I failed to heed the biblical tale, hoping that my

venture will help construct an edifice featuring the language of a new calculus. Perhaps, my effort did not go in vain.

I certainly made an effort to address the language barrier in my report on the general philosophy underlying my concept of indeterminism and the category of predisposition. The idea was to create *predisposition* among the participants to ward better understanding and communication. Moreover, at my request many papers were structured in such a way as to provide an impressionistic image so

The list of the participants of the symposium *Calculus of Predisposition*, their affiliation, and report topics

Introduction

A. Katsenelinboigen
University of Pennsylvania
"Calculus of Predisposition"

Economics and Business

A. Geranmayeh
Interact
"Russell Ackoff's Ideas of Development and Stages of Planning"

A. Heston
University of Pennsylvania
"The Measurement of Economic Development"

S. Schoeffler
Mantis
"PIMS"

A. King
US Army War College
"The Formation of the Index of Vulnerability for Strategic Minerals"

Artificial Intelligence and Mathematics

R. Atkin & J. Johnson
Essex University, UK
"The Concept of Connectivity"

B. Weinstein
University of Michigan
"The Evaluation of a Chess Position"

S. Kudrin
University of Pennsylvania
"Subjectivity in Evaluation of Position in Chess"

L. Kauffman
University of Illinois at Chicago
"Evaluation of a Position in Protracted Games"

Aesthetics, Psychology, Literature

V. Konecni
University of California, San Diego
"G. Birkhoff's Concept of Aesthetic Measurement"

J. Gips
Boston College
"Algorithmic Aesthetic"

D. Giacomo & M. Weismark
Harvard University
"The Utilization of the Concept of Predisposition in Psychotherapy"

V. Zubarev
University of Pennsylvania
"Fate, Chance, and Something Else in Shakespeare's *Romeo and Juliet*"

Military

E. Connelly & K. Myers
Concord Associates
"Combat Effectiveness Measures"

M. Melich
Naval War College
"War and Values of Predispositions"

Theology

H. Wentz
University of the South (Sewanee)

the listeners would comprehend the substance of the presentation (which might eventually crystallize into a concept).

I believe the participants did make contacts. Even the discussion between Sergey Kudrin and Sidney Schoeffler would have justified my efforts. Grandmaster Kudrin was an MBA student at Wharton School of Business; Schoeffler is the founder of the PIMS model, which aims to provide an objective groundwork for the managers entrusted with charting corporate. The dialogue between these two participants revolved around the of setting up a data bank to guide the formation of system's position. Kudrin held that just as in chess, where such a data bank is impossible because most victories at grandmaster level hinge on the subjective valuation of the position, such a data bank cannot be created for the businessmen. Schoeffler maintained that such a data bank, which would *objectivise* the decisions made by the managers, is within reach both in business and in chess. The reader will find an in-depth analysis of this discussion in the chapters dealing with economics and chess. Here the reader is advised to keep in mind the ideas expressed by the Grandmaster Kudrin.

The object of this brief preamble is to present in a nutshell the general concept of the book. Now, a few words about the prehistory of this book. The last twenty five years of my life have been dedicated to research on the problem of indeterminism and its applications to different fields. The results have been expounded in my books *Some New Trends in Systems Theory* (1984); *Selected Topics in Indeterministic Systems* (1989); *Indeterministic Economics* (1992), and *Evolutionary Change: Toward a Systemic Theory of Development and Maldevelopment* (1997*a*).

The present book represents a sequel. I shall try to present new ideas that have not been elaborated in my previous works (which an interested reader can easily find). In the next five chapters, I will reexamine the general philosophical category of indeterminism and elaborate on the application of this concept to chess, economics, ethics (which have been explored in my previous work) as well as to a number of new areas including sociopolitical systems and art.

The chapters do feature certain continuity, but some can be read out of sequence. A reader versed in the topics discussed in the book might go from the introduction, which presents a broad overview of my concept, to chapter 1 which gives a more detailed philosophical description of a specific area of application of this concept, and then to the next similarly concrete chapter. I structured the book so that the reader unfamiliar with the workings of indeterminism might skip directly to the chapter which interests her and, if she is so inclined, proceed in any sequence of theoretical and applied chapters.

Naturally, I have become very *accustomed* to my concept of indeterminism (I even entertained the idea of naming the book *Addictions to Indeterministic Systems*). I would be grateful to any reader who is willing to cast a fresh look at the issues discussed in the book and express their candid opinion on the subject.

1

PHILOSOPHY

The determinism-indeterminism (D-I) category is one of the oldest in philosophy, much debated by specialists. Still, I believe that it is not well-developed. Conceptual understanding of any philosophical category depends upon our knowledge of its gradations, and this knowledge is not yet at an advanced stage as far as the D-I category is concerned. The notion of degree of indeterminism has been ignored by the main streams in philosophy; determinism and indeterminism are mainly opposed to each other in a dichotomous way.

The D-I category has had a bad fortune of being constantly subsumed under other prominent philosophical categories; such as causality, predictability, freedom (including free will), and, for the most part, uncertainty. Indeterminism can stand alone as a major philosophical concept in its own right; though deeply enmeshed with all of the related categories mentioned above, it is not reducible to any one of them. All concepts in philosophy are related to one degree or another, but relation is not the same thing as subsumption.

In this chapter I will try to make the D-I category a little clearer. I will start by making a few methodological observations concerning the definition of the category under discussion. Then I will attempt to reveal its connections with a number of related categories. At the end of this chapter I will devote some time to operationalizing the D-I category.

Methodologically, we should note that in contemporary philosophy the D-I category is discussed both generally and specifically as it applies to different fields of science, art, and religion. My approach will be general, but illustrations will be drawn from specific fields of study. In so doing, I run the risk of confusing the general features of the concept with the particular ones. To mitigate the danger, in the main body of the book the concept will be analyzed within the context of a specific field with an emphasis on its esoteric features.

To help the reader understand this notion and its connection with indeterminism I shall comment on the ontological aspects of this problem in the con-

text of protracted systems. Here, the key construct is the category of the so-called *Janus process.*

This general phenomenon reflects the fact that the development of a system may proceed from two opposite directions: from the *beginning* as well from the *end*. This two-ended approach, which I refer to as the Janus process, is most conducive to the rapid and effective development of any protracted system.

Let us consider one simple case: a system composed of the production chains of different kinds of final goods. As man evolved, or, perhaps, from the very beginning, there emerged multi-link production chains between nature and the final product. Increasingly sophisticated technologies, composed of many stages with many intermediate goods, were developed before the final product could be obtained. However, the production chains thus formed were largely atomized and relatively short. Once the tools and the intermediate products became more versatile, this tangle of production chains was transformed into a unified network.

As long as this network remained relatively simple, a change in any one of its nodes could be completely and consistently traced directly to the end result, that is, the final product. Therefore, with respect to the domain of a system, which yields consistent and complete links between some initial and future states, changes can proceed from the end. This means that the process of development is driven by a well-defined practical objective, namely, the creation of new products or technologies that are integrated in the overall network in a rather complete and consistent manner.

At some stage of human evolution a question arose that marked a revolution in the history of the human knowledge: Why not begin parallel development from the start? The question was posed in the following way: Why not proceed in a parallel fashion, taking any arbitrary link as a starting point and assuming it to be impossible to construct any local criterion that would allow that link to be integrated in a complete and consistent manner with the rest of the network? Tremendous benefits could be reaped from this kind of a parallel development, akin to digging a canal from both ends. At the earliest stages of development, the network is comprised of units (links) that mainly produce versatile products. These considerations give rise to basic and applied science, that eventually contributes to the creation of new final products.

The tremendous benefits of the two-ended approach, however, exact a heavy toll. The problem is that at the beginning the potential worth of any given undertaking may be entirely unclear. In other words, the stage of development attained by individual units is not complete and consistent with the network as a whole. In effect, it is impossible to link the initial and the final states in a consistent and complete manner, even in terms of probabilities based on statistical observations of frequencies. For this reason, investment in the initial link could easily lead nowhere or to a dead end.

More than any other system, the history of mathematics has exhibited such two-ended development. One end was the need to solve practical problems. The other was the desire to explain the harmony of numbers as such. In Egypt the development of mathematics was driven by practical needs, such as geodesy and

pyramid construction. Greek mathematicians, Euclid, and in particular Pythagoras and his followers, professed aloofness from reality and the purity of mental constructs. Pythagoreans, espousing the credo "numbers rule the world," despised practical applications of any kind. Only much later in the nineteenth and twentieth centuries, when the depths of mathematical structures were penetrated more deeply, did the two approaches begin to cross-fertilize each other; for instance, number theory, analysis, and theory of probability. Naturally, the connection between these two approaches has not been fully explored.

Originally, painting developed predominantly as a representation of the concrete. Gradually, as artistic sensibility evolved, the artists began to move away from concrete elements in their work. This is manifest, for instance, in the evolution of Vincent van Gogh's painting comparing his *Boots with Laces* with *The Abandoned Quarry*. Along with the painting of concrete objects, there also appeared painting based on abstract elements and colors. Although all great artists recognized abstract qualities, for a long time they were considered subordinate. Only in the twentieth century, beginning with the work of Wassily Kandinsky, Piet Mondrian, and Kazimir Malevich, did abstract painting begin to assert its independence. All these developments have led to different forms of synthesis of abstract and concrete structures, to the mutual benefit of both.

Whatever the workings of a Janus process, in the general case it is subject to "discontinuities" or gaps, as Hamlet said, "The time is out of joint" (*Hamlet*, act 1, scene 5). This ruptured or segmented Janus process features certain phases. Each phase is characterized by the degree of consistency and completeness of the network of elements comprising the system.

There is one phase of special interest. On the one hand, this phase does not establish a direct (i.e., complete and consistent) link to any final state, and neither does it specify any direction of development. On the other hand, a state of a system (at this phase) does affect the system and steers it along a certain course (or a goal in the sense of a final state). I call this phase a *predisposition.* Chess provides the most elaborated example of formation of a predisposition (see chapter 2). The book discusses in depth other examples of forming a predisposition borrowed from societal systems and economics. These examples corroborate the need to introduce this special intermediate phase.

Aesthetic assessment of the works of art—the subject of chapter six of the book—also features the same duality: lack of direct utilitarian link with any pragmatic state (goal) and certain degree of order (of the object) which creates predisposition toward further development. Beauty is something that enables, however *incompletely* and *inconsistently*, to determine the influence that the present state of development has on future. In this sense the development of beauty is the striving towards the creation of *completed* (in the sense of maximum possible accomplished balance) *incompleteness* (in the sense of creating conditions for future development and disposal of dead ends).

Naturally, the general principles of the analysis of predispositions in different systems do not exclude the particularities of this analysis in nature, in systems artificially created by people, and in art in particular.

In the frame of Janus process I want to treat the D-I concept constructively, which means that I place it in a system that I imagine to be ruled by a demiurge. Alternatively, we could have chosen a system in which the interactions of participants are governed by certain basic rules. To illustrate: The interactions between Man and Nature may be viewed in one of two ways. Under one view, Man is an optimizer subject to Nature's constraints; under another, Man and Nature play a game, each pursuing their own objectives subject to certain rules of interactions (Katsenelinboigen, 1992).

A constructive approach also means that a given category can be studied within any system, including artificial ones, and that a mathematical analysis of these systems is nothing but a representation of the way they function. The results obtain are then compared with experimental and empirical data from the systems already actualized, be they *natural, non-natural,* or *unnatural*.

The system being constructed I treat as a suprasystem, and assume that it is closed. A suprasystem can contain its own systems, each characterized by a particular degree of indeterminacy.

D-I AND RELATED PHILOSOPHICAL CATEGORIES

The Meaning of Determinism-Indeterminism

The D-I category, in my view, pertains to *ineluctability* or *unavoidability* of an event, or more precisely, to the degree of its inevitability. Must the event occur given the initial conditions, the way the system functions, and its transformation mechanism, or might the outcome be changed if the system's components are not yet completely fixed and may vary? In other words, the degree of indeterminacy is the degree of our ability to change the path of a system as its constituent parts themselves change.[1] If our ability to change the parts is finite, the occurrence of a particular event may be ultimately unavoidable. This is determinism, the case of an inevitable event. Indeterminacy, on the other hand, is characterized by avoidability or alterability of an outcome of an entire category of events rather than a single outcome. For instance, a category of some possible outcomes may be unavoidable, while some particular event belonging to that category is avoidable. I shall illustrate this point with examples from quantum mechanics and with respect to interpreting the meaning of life. This scheme applies to equifinality: the outcome is inevitable while any single path leading to it is avoidable; also to closed and open systems or subsystems.

Such approach to D-I is very close to the concept of *defeasible reasoning* in philosophy mainly developed by Roderick Chisholm and John Pollock. This concept (in artificial intelligence it is called *non-monotoning reasoning*) assumes that it is possible to revise earlier conclusions in light of new evidence. In the frame of *defeasible reasoning* Steven Kimbrough and Stephen Roehrig (1997) elaborated an approach to measure the degree of indeterminicy.

> How many new variables must be added to "make the problem go either way"? If one problem requires fewer such variables than another, then the former must somehow have more slack—indeterminacy—built

> into it. That is, the more indeterminate a problem is, the less we require "unusual circumstances" to illustrate its indeterminacy. By showing that the problems considered here vary along this dimension, we make the argument that the number of additional variables is useful as an inverse measure of indeterminacy. (p. 23)

I found this approach provocative even in many situations it cannot be operationalized. Moreover, to operatinalize such an approach one has often to know the performance procedures because it is difficult to find the number of additional variables that are invariable to these procedures.

Sometimes, in reading about the interactions of two systems, we come across the words *determining* and *determined*, the former used to describe a stronger impacting system and the latter a weaker one being impacted. My definition of the D-I category is different, but as to the case in point, I would prefer to use the designations affecting system and affected system, respectively.

Determinism can be either *potential* or *effective*. This is a very important distinction.[2] A potentially deterministic procedure generates a definite unavoidable outcome; the trouble is that it cannot yet be operationally found. A procedure that is effectively deterministic unfailingly produces a definite result when put into operation. The fact that the latter procedure may be iterative, producing iterations occasionally avoidable, does not negate its effective determinateness. To distinguish avoidable iterations in deterministic procedures from similar outcomes in indeterministic procedures, the former may be designated as iteratively deterministic.

With potential and effective determinism we can have three possible states of a system: potentially and effectively deterministic, potentially deterministic but effectively indeterministic, and, lastly, both potentially and effectively indeterministic. The system, in principle, cannot be potentially indeterministic and effectively deterministic.

One such system, potentially deterministic but effectively indeterministic, is chess. It is potentially deterministic because, theoretically, one can find the best, optimal line of play leading ineluctably to victory by working through all the possible move sequences. But since the number of all possible moves equals 10^{120}, it is clear no computing machine, even the most powerful, can do a complete check of all lines within the time-frame of a real chess game. Hence, chess is effectively indeterministic.

The D-I Category versus Certainty-Uncertainty Concept

I highly appreciate the recent trend in science concerning a deeper analysis of uncertainty. The concept of uncertainty was attacked from above and below. In this regard it is interesting to mention the book by Michael Smithson (1989) where the reader can find on page 9 a hierarchical typology of categories related to uncertainty. *Uncertainty* itself is treated "as some form of incompleteness in information or knowledge" sharing it with another category—*absence*. From above uncertainty is subordinated to *ignorance* that "usually is treated as either

the absence or the distortion of 'true' knowledge" (p. 1). From below uncertainty is subdivided on *vagueness, probability,* and *ambiguity*; in its turn, *vagueness* can be subdivided on *fuzziness* and *nonspecificity*.

For the purpose of my study, it is sufficient to treat uncertainty as a generic term for the incompleteness in information. In this sence of the term, certainty-uncertainty (C-U) category has been analyzed most rigorously in philosophy and information theory, in general, and in physics and game theory, in particular.

Information theorists study uncertainty through the agency of entropy. The reader can find a good historical description of this issue in (Iaglom amd Iaglom, 1983).

In philosophy uncertainty has been equated with indubitability, as opposed to a state of doubt regarding a particular phenomenon and its characteristics.

Physicists have evolved the *Uncertainty Principle,* which states that the speed and position of an object cannot be measured exactly at the same time. This principle is crucial in quantum mechanics. Thus, in physics uncertainty refers to the impossibility of determining simultaneously and precisely the necessary characteristics of physical objects.

In game theory (Luce & Raiffa, 1957), uncertainty belongs to the realm of decision making and is defined as follows:

> As to the certainty-risk-uncertainty classification, let us suppose that a choice must be made between two actions. We shall say that we are in the realm of decision making under:
> (a) *Certainty* if each action is known to lead invariably to a specific outcome (the words prospect, stimulus, alternative, etc., are also used).
> (b) *Risk* if each action leads to one of a set of possible specific outcomes, each outcome occurring with a known probability. The probabilities are assumed to be known to the decision maker. For example, an action might lead to this risky outcome: a reward of $10 if a "fair" coin comes up heads, and a loss of $5 if it comes up tails. Of course, certainty is a degenerate case of risk where the probabilities are 0 and 1.
> (c) *Uncertainty* if either action or both has as its consequence a set of possible specific outcomes, but where the probabilities of these outcomes are completely unknown or are not even meaningful. (p.13)

In game theory, then, uncertainty reflects a degree of risk in choosing among a number of alternatives that have different probabilities of occurring. We should note that in philosophy, unlike in physics or game theory, certainty is a property of knowledge per se, whereas with the latter two it is only a measure of how precisely we can determine the numerical values characterizing a state of a physical object or the probabilities of various outcomes in decision making.

But if certainty is to be obtained, we need more than indubitability. We also require: (a) specific knowledge about an event that permits no deviation from an ideal specific description of this event, that is, zero fuzziness; fuzziness being a

result either of abstraction, when an event is represented by only a few of its characteristics, and/or aggregation, when it is included in a group of other events expressed in terms of consolidated averages; (b) precise knowledge of an event that implies zero degree or zero probability of deviation from its ideal numerical characteristics; and (c) constant integer probability of occurrence of a single event in a given situation. (With noninteger probabilities we only know that the chance of an event occurring is distinct from either zero or one.)

The three conditions listed here are interrelated and lend themselves to trade-offs; trade-offs, in turn, reflect a degree of certainty. For instance, by relaxing the demands on specificity and precision we can increase the probability of an event occurring. An optimal mix of trade-offs is situation specific. Unfortunately, I am not familiar with any efforts to measure degrees of certainty in terms of tradeoffs. The notion of degree of certainty has always been tied to probabilities (Iaglom and Iaglom, 1983).

Now, to the relationship between the D-I and C-U categories. Apparently, uncertainty is a product of indeterminism. But uncertainty can also be a product of determinism, under the view of determinism proposed here. In fact, determinism can result in uncertainty when there are definite built-in unavoidable limits on increasing the certainty of events occurring in a system. Certainty always presupposes determinism because determinism is an extreme case of unavoidableness.[3] But determinism is not a sufficient condition of certainty because not all cases of determinism involve *complete* certainty.

To make these abstract formulations a bit more tangible, let us apply them to quantum mechanics. Basically physicists use *uncertainty* and *indeterminacy* interchangeably.[4] In my view, though, uncertainty refers only to the impossibility of measuring exactly the speed and location of an object at the same time, whereas indeterminacy fixes this impossibility in the very nature of particles that act simultaneously as waves.[5] Hence, the Uncertainty Principle, as understood by physicists, hypothesizes a deterministic state of affairs rooted in the immutable nature of particles-waves.

It may be useful, therefore, to fine-tune the notion of determinism by drawing a new distinction between conditional and unconditional determinism. The latter always involves certainty; the former may be associated with uncertainty. The extent of conditional determinacy is dictated by degree of uncertainty. This distinction will come in handy in the analysis of deterministic and indeterministic procedures, with conditonal deterministic procedures often resembling indeterministic ones.

The D-I Category and the Concept of Causality

The prevaling opininon concerning the D-I Category is conveyed by the *Encyclopedia of Philosophy* (1972): "Determinism is the general philosophical thesis which states that for everything that ever happens there are conditions such that, given them, nothing else could happen."

This definition reduces the D-I Category to causality. Causality indeed means that for any event to occur, there must be a set of sufficient causes. It

stems from a rather simple notion that there can be no change without a cause, which is similar to the idea that something cannot come out of nothing.

What is at issue with the D-I Category, is not whether there exists a complete set of event-producing causes—such a set always exists—but whether this set can be altered and the event avoided.

The D-I Category and the Concept of Predictability

It is widely held that determinism entails the prediction of all future (as well as past) states of the system. It was this particular feature of determinism that formed the groundwork for the classical treatise of the problem by French mathematician Pierre Laplace. Laplace postulated that given the coordinates and the impulse of all the objects in the universe at a given moment, it would be possible to determine all future and past events by means of Newtonian mechanics.

This brand of determinism was developed significantly in the works of an outstanding British philosopher of this century Karl Popper. In his 1982 work, Popper proposed a definition of determinism that presumes: "the doctrine that the structure of the world is such that any event can be rationally predicted, with any desired degree of precision, if we are given a sufficiently precise description of past events, together with all the laws of nature" (1982*a*, pp. 1-2).

In my opinion this statement of determinism is expliciltly incomplete because it ignores the power of the system's transformation mechanism, or implicitly assumes that it is all-powerful. If indeed such a mechanism exists, then the notions of *determinism* and *complete predictability* become one.

Let us slightly refine Popper's concept of determinism and predictability. Assume that it is true only of *potential predictability*. Let us additionally introduce the notion of *effective predictability*, which limits predictability to a particular time-period, such that no event beyond the cutoff point can have any impact on the transformations during the specified period. Then, even a transformation mechanism with limited power can make the system predictable.

But on the whole, in my opinion, determinism is not an equivalent to predictability (whatever its time-sign).

We may have a deterministic system that in principle rules out predictions of its future. A feasible set of future states changes as the fully deterministic system itself moves forward. Indeed, let there be an ideally deterministic system whose future influences events in the present. Predicting its future takes time because the transformation mechanism works only with a certain speed that does not exceed the speed of light or some other appropriate universal constant. Thus, prediction time is fixed, and so, too, is the forecasting horizon beyond which we cannot move during a given time-interval. States beyond the horizon, however, influence the transformations of the system that is inching from the present to the horizon. This is an example of a deterministic system that inevitably and unavoidably, deterministically precludes complete predictability of the future.

If, in addition, we postulate a certain hierarchy of transformation mechanisms, in other words, a metamechanism of transformations, then the possibility of coexistence of determinism and unpredictability becomes even more obvious. A state generated by the first-level mechanism influences through feedback the second-level mechanism, which will alter the mechanism of the first level, and it, in turn, will do the same to the base-level mechanism.

Perhaps, the separate nature of the D-I and predictability categories can be further elucidated by recourse to another classical problem that springs from the notion of determinism, namely the problem of fate. Those who believe in fate may hold that its workings are absolutely incomprehensible to human beings, and yet fate is determining the course of development of all objects under its sway (Bernstein, 1992).

Fate on that view may govern not just the interactions between man and his enviroment, but also the inner life of the human being who, lacking willpower, constantly vacillates between conflicting emotional states—the manifestations of his genetic make-up or fate—and conflicting cognitive assessments of their causes. I wll have more to say on this matter later on in the book.

The D-I Category and Freedom

Freedom appears essential in classifying systems as deterministic or indeterministic. A degree of freedom is fixed by the number of independent variables that determine the state of the system.

George von Wright (1974) defines degrees of freedom in a formulaic way:

$$\frac{k - 1}{2^n - 1}$$

Wright's ratio is constructed as follows. He takes an arbitrary occasion in time, distinct from both past and future, and assumes that at this moment the world is in a certain state. At the next moment the world, theoretically, can be in any one of 2^n states formed by "n-logically independent elementary states, which, we assume, provide the "building bricks" of our world" (p. 17). But due to constraints on transformation paths the world can take, the number of possible states is reduced to k.

Degree of freedom, thus defined Wright, associates with degree of determinism. But the existence of a degree of freedom is in my mind not a sufficient condition to claim for indeterminism. I do not believe that degree of freedom and degree of determinism are synonymous or reducible to one another, however close their affinity may be.

Let us recognize among the system's components *fundamental methods/rules of transformation* and *performance methods/rules of transformation*.[6] The former makeup the basics of a system, the latter constitute essentially the system's algorithms. (We ignore the purely formal implications of the word algorithm, which denotes a rigorous repetitive procedure of transforming inputs into outputs.)

If a system is represented as a black box, these two types of methods/rules are hidden, being phenomenologically manifest in a transformation function mapping inputs onto outputs.

If a system is represented as a white box, fundamental methods and performance methods are easily distinguishable. If the same inputs can be processed by different fundamental methods, performance rules help define the intensity of usage of different fundamental methods.

The white box that possesses degrees of freedom resembles an indeterministic system. However, given that its performance methods are complete and consistent the white box is not indeterministic. The results of operation of a black box and a white box are the same. The only differences is the manifestation of the different modes of representaion (Katsenelinbogen, 1992).

Let me express the above made statement in other words. One can distinguish two broad modes of representation: *reactive* and *selective*. The reactive class presumes the existence of a law linking system's inputs and outputs. Here, inputs play the crucial role for they determine the output via the governing law. This mode of representation creates an impression that the system is completely determined. The selective class of methods presupposes certain degrees of freedom brought about by the forces of attraction and repulsion. The balancing of these forces carried out by means of an algorithm constitutes the core of the system's operation. Under the selective mode of representation the system appears to be indeterministic.

Under certain conditions, the reactive and the selective modes of representations turn out to be isomorphic. Both an algorithm and a law are merely two ways to represent programs which spell out the behavior of a system. However, some researchers regard the first mode of representation as deterministic and the other one—as indeterministic.

Both of these modes of representation can be completely deterministic since an algorithm fulfills the same determining role as a law. From this point of view, the concept of indeterminism is based on the development in the twentieth century of a program as an object for elaboration. Programs for computers, genom, technology for mass production can serve as examples of such objects.

The avoidable level of completness and conistency of a program stipulate the degree of indeterminicy. The completness of a program in its turn is recognized by the degree of free space with the program have for changes. Trial and error based on a fully irregular but changeable program, on the one hand, and algorithms which convergency is fully proved in a constructive way, on the other hand, can be recognized as examples of two extreme cases of full indeterminism and full determinism, respectivly. Obviously, a program that is not complete and consistent and can not be changed is also a deterministic one, and its usage can sometimes bring ugly results.

Between the extremes one can see the whole spectrum of programs that increase the determinicy of the solution of a problem.

Thus, the system is indeed deterministic if it has no degrees of freedom, regardless of whether this is a result of fundamental or performance rules. But the converse does not hold. The system may have degrees of freedom and still be

deterministic if the outcomes that it produces inexorably fall into unchangeable pattern either because the program is complete and consistent, or, even it is not so, cannot be changed.

The D-I Category and Free Will

The discussion of the D-I Category and Freedom next brings to the subject of *free will*. That they are related can be gathered from the some definitions of determinism, in particular provided by *The American Heritage Dictionary* (1990): "The philosophical doctrine that every event, act, and decision is the inevitable consequence of antecedents that are independent of the human will."

Will is first of all the ability of the human being to realize his plans in life, hence *will power* is a measure of this ability. Free will means that man can vary his will power in pursuing life's objectives. A lack of free will means that will power is fixed, so that any change in man's behavior is categorically ruled out.

The problem of responsibility illustrates the above statement. On the one hand, the environment imposes certain restrictions upon an individual expressed in social values, such as thou shall not murder, thou shall not steal, etc. An individual may possess other values and enjoy killing others, but his liability is determined by his capacity to perceive the requirements imposed by the environment and consequently adjust his behavior. If an individual is incapable of such adjustments, he is not held responsible. Indeed, insane people are regarded as not being responsible for their actions precisely because their program of behavior fails to fulfill all or just one of the necessary conditions: to internalize external constraints and to generate a proper behavioral response.

A criminal is deemed in a given society precisely because he is considered capable, at least in principle, of altering his conduct according to the dictums of the environment, but failed to do so because of his individual values that gave him greater satisfaction from ignoring these dictates.[7]

Punishing the criminal is the same as actualizing for him the potential system of punishment. This may prod him to change his individual values and avoid crime in the future.

Let us pursue the subject of free will a little further within the framework of the types and levels of programs.

First, programs differ in their sources of origination. There are biological programs that are innate, and there are cognitive programs that are acquired by the individual throughout his life. Both types of programs may have different levels, more or less powerful. *Behavioral program* which, according to Herbert Simon, governs the behavior of the system directly will be denoted as a zero-level program. A first-level program is a program that changes the zero-level program, the second-level program is a program which changes the first-level program, etc. The mere ability of a first-level program to alter a zero-level program is sufficient to speak of the zero-level program as an indeterministic one.

Of course, if the hierarchy of programs is truncated at the first level and if the first-level program is deterministic, the zero-level program will also eventually become deterministic, and so will the entire system. But if the hierarchy has

at least two levels and if it allows for change-inducing feedback between different levels, the whole picture changes dramatically.

The described hierarchy of programs resembles the system of education (second and higher levels of programs). Their affinity is revealed if we consider that as a result of learning (based upon one's own experiences and deliberations as well as the experiences and deliberations of others) a given-level program causes changes in adjacent-level programs.

Moreover, assume that zero-level programs may be run either in imagination or in real life. Playing out the possible consequences of one's actions in the mind's eye could be beneficial because the results of this exercise may induce changes in the second-level program that will alter the first-level program, that is, the one directly responsible for the zero-level program. If, however, the individual is incapable of running the program in his imagination to the end, it recedes into the illusory realm of his consciousness and, in time, starts posing a threat to his psychological integrity. All the while, the individual's will power can be either strong or weak. In either case, a lack of free will results in all kinds of psychological disorders, be it a maniacal pursuit of the zero-level program if will power is strong, or total inability to do anything to realize the objective if will power is weak. In the latter extreme case, any attempt at attaining one's goal produces complete physical and nervous exhaustion.

With respect to cognitive programs, we may say that a cognitive program of a given level is influenced by a biological program of the same level. The reverse influence of cognitive programs on biological ones is beyond the scope of this book.

In general, biological programs seem to be more conservative and rigid than cognitive ones for they reflect a long list of accumulated experiences of living organisms acquired in interaction with their enviroment. Biological programs are largely hereditary. We can clearly see that different types of human character—if by character we mean a biologically fixed emotional system of different people—have not perceptibly changed over the millenia. That is why some theatre directors, to emphasize the unalterable nature of human emotions, dress their actors playing ancient Greeks in modern-day costumes. As to cognitive programs, they do change quite rapidly under the impact of a fluid, artificial man-made enviroment, that is, new kinds of food, weapons, etc.

For example, the sensations that we feel from eating are biologically determined and seem to be correlated with our need for different kinds of foodstuffs. These sensations are not likely to have changed much in the course of human history. Civilization, however, has produced foodstuffs that have a heightened effect on our gustatory sensations, inducing us to eat more than physiologically necessary. The tension between the biologically determined gustatory sensations and artificially manufactured producs, brings on a full-scale war between intellect and will, on one side, and the biological drives, on the other—with the latter often winning by supressing both intellect and will.

The same full-scale war between intellect and will, on one side, and the biological drives, on the other—with the latter often winning by supressing both intellect and will—one can observe relative to weapon. (See chapter 5).

Thus, will and will power may be viewed as the ability of man to carry off his zero-level cognitive program and to change a cognitive program of a given level through changing a higher-level cognitive program. They also involve the ability of man to supress the desires that produce a conflict between his emotions and his cognitive judgments, that is, free his first-level cognitive program from the grip of the affecting same level biological program.

The D-I Category and Openness

It appears that an open system implies deterministic development, since the external factors affecting the system are unavoidable. In principle, it is indeed possible to define certain conditions under which an open system is indetermined. One precondition is that the given open system possess a protective shield which would ward off all the disturbances coming from the environment or possess sufficient flexibility (and adequate reserves) to assimilate all the perturbations generated by the environment.[8]

Of course, the above conditions are rarely fulfilled, so an open system is primarily deterministic.

A Systems Vision of D-I

Let us use the systems multidimensional approach to summarize the discussion concerning the relations of D-I with other philosophical categories. Such a summary allows to have a multiface definition of D-I.

From the *functional* point of view the D-I category pertains to *ineluctability* or *unavoidability* of a given event.

From the *structural* point of view D-I is leaned to existence of components that can change the given event.

From the *operational* point of view D-I is based on the existence of a complete and consistence procedure that allows to find the given event.

From the *operator* point of view D-I is related to the existence of an operator that is able to calculate a future event that does not influence on the trajectory of development of a system till it achieves this future event.

From the point of view of *genesis* the attitude to D-I concerning the future is symmetrical to its attitude in the past.

DETERMINISTIC AND INDETERMINISTIC PROCEDURES

General Observations

Any approach to the D-I Category, it seems, has to deal with the completeness and consistency of spatio-temporal relations that exist in a given entity. In other words, to study the dynamics of an entity is to study the procedures or mechanisms that connect the successive movements of the entity on the assumption that there are means to effect the said connections. By a movement I mean the entity's passage between two adjacent stages.

Any entity, in general, consists of four parts: (a) formed and transformed elements, (b) relations between the elements, (c) methods and/or procedures used to transform the elements, and (d) means and/or tools of transformation.

In analyzing any entity we distinguish both, as the initial objects (parameters), that is, elements, as the initial relations (parameters) between these elements. The elements are recognized an *indivisible*. In some entities the elements are *absolutes*, in some—*relative* to the needs and possibilities of the analyses of a given entity. In many artificial entities elements can be designed as absolutes, e.g., the pieces in chess. In natural entities there are not absolute elements: they always can be further divided, e.g., planets, living beings, chem- ical elements, molecules, atoms, particles, etc.

The elements and the relations between them can be *grouped*, forming a *composite*. A composite can have many subcomposites and even a multilayer structure. A very interesting question is arising: Are the relations isomorphic between the subcomposites on different layers of a composite? The answer on this question has many practical applications. For example, William Fulbright (1966) spent a whole chapter (pp. 151-177) on the isomorphisms of the relations between countries and human beings.

I am leaving open to the reader the answer on the question concerning the isomorphisms between the subcomposites on different layers. It seems to me, that the answer on this question may also involve the grouping of relations.

The notes concerning composites bring us to a following set of definitions. A group of elements is called an *aggregate* if it doesn't contain relations between the elements. A *system* involves both, as the elements, as the relations between them (see Kramer & de Smith [1977]; Laszlo & Laszlo [1997]). In my future analysis I will refer to *composites* represented as systems, except cases when the entities are aggregates.

The elements, collectively, through all the mediated relations made possible by the existing methods and tools, determine to one degree or another a future course of the system. To measure explicitly the power of their impact we need to know along with the *initial* parameters of the system their *dual* parameters. The initial parameters necessarily include those that make up the anatomy and the physiology of the system. We shall refer to them as *essentials*. The initial parameters may also contain the *relations* between elements; the concept of relations requires a separate treatment. The initial parameters (the essentials and the relations) can have *dual* parameters that act as a kind of a motive force of the system. Let us call the dual parameters *attractors* or *repulsors*.

To cite specific examples, in thermodynamics the initial and dual parameters apply equally to extensive and intensive characteristics of the system (energy and temperature, respectively, or volume and pressure); in quantum mechanics we have the original particles and the connecting particles, the socalled *dual partners*; a living organism posesses its anatomy and physiology, on the one hand, and feelings that serve as valuations of the organism's specific biological features, on the other one; in economics, there are products (resources) and their prices; in social systems, there are human interactions and their valuations through laws or customs.

These pairs of parameters are not always made explicit; whether or not they are explicit depends on the way the system is represented—and this, in turn, is a function of the way the problem is solved.

Linkages between the states of the system can be effected in two ways: Successively, following the constraints on transformation of one state into another, or by separate actions that involve only a subset of the state's constituent elements. *Heuristics*, often called *rules*, for instance, *rules of thumb*, exemplify a second type of linkage through separate actions. These rules cover conditional and unconditional reflexes in physiology, moral precepts like the ten commandments, rules of grammar, etc. This kind of linkage is quite economical, for it does not call for tying together all the constituent elements of the states being linked. As to the assessment of various actions, it is basically a difference in the assessment of the initial state (or some relevant subset of that state) and the resulting state (or some relevant subset of it) brought about by the action.

The second type of linkage is not universal, it works only in certain situations, for instance, in those in which we can make use of abstracting procedures. These methods may be recommended if it can be proven statistically that they work in many different types of settings, and are not contradictory. But this kind of statistical proof is often accompanied by a list of exceptions to cover special cases. Thus, in linguistics there is a rule that covers most of the ways a word is transformed, and there are exceptions to the rule.

The linkages, whether they are formed successively or through separate actions, are of two types: *reactive* and *selective*. Reactive linkages are reflections or formulae that establish a correspondence between one state and another. These formulae sometimes take the form of singular constrains on the ways the states are to be transformed, explicitly expressed only by the initial conditions; conjugated variables may be hidden in the reflection, that is, expressed implicitly. With selective linkages, correspondences between various states are expressed through algorithms that balance the initial and the dual (conjugated) variables of the system.

Finally, if a system has a set of actors (subsystems) and each subsystem, in turn, has its own inherent set of attractors, any given state of the system is defined by a triad of variables: The original entity itself, *essentiality*, and a pair of its dual entitities; let's call the latter *local* and *global attractors* or *repulsors*. In living organisms such a triad consists of its essential anatomy and physiology, and *feelings* that represent the local valuations (importance) of various stimuli for some part of the organism and the the global valuations of the same stimuli for the organism as a whole; global valuations control how the stimulus is apportioned throughout the organism. In economics, there are products (resources) and their valuations by individual consumers through their utility functions and by the entire economic system through the price mechanism. In social systems, there are human interactions and their valuations by individuals, on one hand, and by the society as a whole through its laws and customs, on the other.

Before moving on to the notion of levels of indeterminism, I would like to make three comments. First, I approach this notion from the standpoint of a systems designer. Second, I will deal only with effective indeterminism and leave

out what is potential variety. Third, deterministic methods that exhibit incomplete linkages between the system's elements and indeterministic methods will be operationally indistinguishable. Therefore, I will ignore the former methods and focus on the latter ones.

Phases (Levels) of Indeterminism

Having expanded our understanding of the notion of movement of a system, we are now in a position to tackle the problem of finding in a constructive way the degree of indeterminism. Let me adopt an instrumental approach sometimes employed by physicists when they introduce the concept of measure. Changes in the structure of matter at a molecular level are associated with changes in temperature, that is, the speed at which molecules move around. Although there exists a continuous function which describes this relationship, physicists frequently choose to introduce various phases in the structure of matter (plasma, gas, liquid, solid states). From an operational perspective, each phase is distinguished by its respective phase-specific technologies.

I shall follow the physicists' footsteps and divide the continuous spectrum of indeterminism into *phases*, each of which is distinguished by different orderings of interacting components of a system and possesses its own methods of solving problems peculiar to a given phase.

A few clarifications are in order. Orderings here imply determinism, but do not imply certainty and negative entropy. Under my definition determinism is synonymous with inevitability but not with certainty. (Recall the example from quantum mechanics.) Moreover, my approach calls for assigning values to outcomes, which does not happen when uncertainty is equated with entropy. In other words, since I consider orderings together with their attendant constraints, I do not treat indeterminism as equivalent to entropy, as entropy is conventionally understood in information theory, where it is not subject to constraints (Iaglom and Iaglom, 1983). An analysis of systemic entropy in the context of differently valued outcomes can be found in (Pittel, 1972).

To simplify somewhat the discussion of levels of indeterminism, I will first proceed on the assumption that determinism is characterized by complete and consistent linkages between the system's elements. At the end of this chapter I will remove this assumption and show the consequences of doing so.

The figure below (Figure 1.1) illustrates the phases (levels) of indeterminism with the above mentioned assumption in place.

It may be argued that what accounts for different levels of indeterminism is the varying possibilites of ordering the linkages between the system's elements completely and consistently, that is, making them ineluctable. Thus, at one zero end of the spectrum there will be complete indeterminism with no ordered linkages between elements, and, at the other, there will be complete determinism with totally ordered elements interacting in perfectly predictable ways. (It will be recalled that for the time being I treat determinism as a case of complete and consistent linkages between the system's elements.) Throughout the rest of the spectrum the interactions of elements exhibit varying degrees of order.

In writing about different levels of indeterminism I want to avoid a possible impression that determinism, even free from the assumption that it is synonymous with total certainty, is my ultimate ideal. My ultimate ideal calls for creating preconditions for development that, in their totality, maximize the possible combinations between the elements and provide the means to realize the greatest possible number of desirable combinations. The maximization objective is a

Figure 1.1
The Phases of (D-I), Their Origins, and Methods of Performance

Phase	Degree of Ordered Interactions Between Elements	Methods of Ordering	Results
Mess	Sporadic Interactions Between Elements	Acquisition	Problematic
Chaos	Directed Interactions Between Basic Rules and Accumulation of Experience	Directing	Development Paths Tending Possibly to Extreme States
Predispositioning	Determining Incomplete Linkages Between Elements	Satisficing	Predispositions
Programming	Determining Complete Linkages Between Elements	Programming	Optimal - Equilibrated Development Paths

classical antientropic device. It is a necessary condition of development that ties innovation to having the greatest possible number of ways of recombining the system's elements. If the world were completely ordered, a finite number of elements in it at any given time would make the creation of new combinations impossible. Here I talk about the growth of entropy with reference to the basic elements of the system. Therefore, the development process involves the build-down of existing structures to the level of elements that, with given methods, allow for the making of new combinations. Moreover, the newly created structures may come to serve as means of enlarging the set of possible combinations through a further build-down of basic elements.

The newly created structures, incidentally, can be made up of the same basic elements as the original system itself. Thus, the development process, broadly speaking, consists in destruction that increases a number of possible combinations between the system's elements (through the build-down of existing structures, as well as of their consituent elements) and creation of new structures.

C'est la vie!

Let's look at the D-I phases in greater detail. The exposition will proceed on the abstract level, without illustrations from specific fields. At the end, though, I will provide one example of how the different phases can be combined.

Mess. The zero phase can be called a mess because it contains no linkages between the system's elements. Such a definiton of mess as “a disorderly, untidy, or dirty state of things” we find in *Webster's New World Dictionary*

(1980). The definiton of mess can be relaxed somewhat to include sporadic, fragmentary linkages between the elements.

The acquisition of elements and fragmentary linkages can serve as a starting point for introducing certain constraints on and formulating motive forces for the development of the system.

The zero phase can be further ordered to enable us to formulate the system's *problematic.* I will make all of this a little clearer when I produce an example illustrating the unity of the entire framework.

Chaos. Mess should not be confused with the next phase, chaos, as this term is understood today. Arguably, chaos is the first phase of indeterminism that displays sufficient order to talk of the general problem of system development.

The chaos phase is characterized by some ordering of accumulated statistical data and the emergence of the basic rules of interactions of inputs and outputs (not counting boundary conditions). Even such a seemingly limited ordering makes it possible to fix systemic regularities of the sort shown by Feigenbaum numbers and strange attractors.

Important regularities of the sort produced by Feigenbaum numbers can, perhaps, reveal a general direction of system development. Moreover, and it can be stated rather confidently, strange attractors are helpful in delineating the extreme cases in system development, given a set of constraints on the basic methods of interactions between elements.

Different types of orderings in the chaos phase may be brought together under the notion of directing, for they point to a possible general direction of system development and even its extreme states.

But even if a general path is known, enormous difficulties remain in linking algorithmically the present state with the final one and in operationalizing the algorithms. These oblectives are realized in the next two large phases that I call *predispositioning* and *programming*.

At this point I would like to change the order of exposition, and instead of proceeding from less deterministic systems to more deterministic ones, move in the opposite direction. I will start with the deterministic phase of programming, which is defined by the presence of complete and consistent linkages between the system's elements.

Programming. When linkages between states are established through reactive procedures, either by table functions or analytically, it is often assumed that each state is represented only by essentials. For instance, the production function in economics ties together inputs and outputs in physical terms. When a system is represented as an equilibrium or an optimization model, the original and conjugated parameters are stated explicitly; in economics, they are products (resources) and prices, respectively.[9] Deterministic economic models have been extensively formalized; they assume full knowledge of inputs, outputs, and existing technologies.

An important subset of selective methods is optimization methods used in the analysis of multistep processes. I call them protracted processes, either in space or in time, where each step has to be judged from the perspective of the

overall goal. In other words, local decisions at each step have to be related to the general solution of the problem, and, additionally, local decisions have to be final in a sense that they are not affected by decisions at subsequent steps.

With respect to evaluating individual steps from the standpoint of an overall goal, there is an interesting set of problems in which a state of the system is expressed through a polynome (often, a linear one) whose variables are essentials with coefficients represented by integral valuations; that is, valuations that, even when used by themselves, produce optimal local decisions. In other words, valuations of essentials establish a correspondence between a global problem and a local one, such that, solving the latter problem, we find a local extremum that is part of the optimal path of the system as a whole. Various methods of solving dynamical problem in mathematics (Bellman's dynamic programming, Pontriagin's maximum principle, block programming of Dantsig-Wolf) make such correspondences possible. Optimization criteria of local problems (often expressed as a linear polynome) treated by these methods, contain integral valuations of essentials (Lagrange multipliers).

Predispositioning

Now let us look more closely at the phase of predispositioning that exhibits less complete linkages between system's elements than programming but more complete than chaos. I call this phase predispositioning because solutions at this stage are only potentially realizable. Following Herbert Simon (1982*a*) this phase can be alternatively designated as satisficing.

Solutions here are expressed explicitly or implicitly in terms of probabilities, if we conceptualize probaility broadly enough as a chance of an event occurring. This approach is embedded in the axiomatic probability theory developed by Andrey Kolmogorov (1956) and is based on the mathematical notion of measure. Another approach to probability, associated with Richard von Mises (1939), is grounded in statistics and frequencies of events. It is crucial for my inquiry to treat probability in a broad sense, the frequencies approach to probability is also consistent with my analysis.

The exposition of predispositioning will consist of two parts. The first part will deal with the ways a system is represented by means of essentials and their valuations; in the second part, this scheme will be enriched by relations and their valuations.

First Stage of Predispositioning. The reactive methods of linking system's elements at this stage include isolated rules or heuristics (rules of thumb) that can be incomplete or inconsistent and whose probabilistic character is not explicitly revealed. Such as, for example, a business strategy of a firm that calculates its advertisement budget as a fixed percentage of sales, or repairs its equipment after certain intervals irrespective of the actual condition of equipment. Optimal planning methods, on the other hand, will tie together advertisement expenses, the actual condition of machinery and other factors completely and consistently, and will therefore produce better results than those obtained by isolated rules of determining the values of individual economic variables.

More developed reactive methods rest on situation-specific statistics and established frequencies of succession from one state to another.

Selective indeterministic methods embrace a wide variety of procedures that cannot integrate all of the available information and, therefore, produce only probabilistic estimates.

There are many selective methods that use probabilities to set the original values of such parameters as essentials or correspondences. These are the methods of *stochastic programming*. They generate their results unfailingly, producing complete and consistent linkages between elements, albeit probabilistically. It should be noted that predispositioning methods, as well as programming ones, make use of valuations in building linkages between essentials, with valuations also expressed in terms of probabilities.

If we assume that the values of variables in our methods cannot be anything but probabilistic, then, taking a cue from Andrey Kolmogorov, we should consider such methods *stochastically deterministic* (see Dynkin, 1989). On the other hand, probabilities may also mean that the procedures used to transform inputs into outputs ignored a possibility of richer linkages between the elements.

Indeed, there are deeper methods, such as stochastic programming, that introduce artificial new variables in the form of reserves (built into the existing pairs of variables) and thus not only help avoid probabilistic solutions, but also may ultimately and unavoidably generate perfectly definitive magnitudes. There is another procedure called *Statistical Sequential Analysis* (optimal stopping rules) that accumulates information as it unfolds; eventually, there may be enough information to effect complete linkages between the states of the system (Shiriaev, 1973).

Second Stage of Predispositioning. A much more challenging problem arises when there are no statistics, stochastic programming or sequential analysis to generate probabilites, considering especially that sequential analysis starts with some a priori probability distribution and may take an incredible amount of time or resources to produce an optimal solution. Additionally, there may be unique situations that by definiton preclude any reliance on frequency of events whatsoever. In this case, rather than observe a highly uncertain behavior of individual objects, we look at the behavior of the total ensemble formed by these objects, since the latter, generally speaking, are more amenable to statistical patterns; in other words, we reduce a unique situation to some previously known one by stripping the former of its specific unique features. This, however, is a pretty risky procedure since the specific features of a unique event could be quite significant, and eliminating them might result in a drastically distorted estimate of the likelihood of the situation occurring.

These difficulties were brought to light by Frank Knight (1971). Along with a priori and statistical probability, he introduced the so called *estimates*. The latter class is described as:

> Estimates. The distinction here is that there is *no valid basis of any kind* for classifying instances. This form of probability is involved in the greatest logical difficulties of all, and no very satisfactory discussion of

> it can be given, but its distinction from the other types must be emphasized and some of its complicated relations indicated. (p. 225)

Knight's remarks about estimates, being quite precise, rightfully constitute a first step toward developing a new calculus of probabilities. The next step, it seems, was taken by Karl Popper (1959). Although Popper intended his inquiry to apply only to to quantum mechanics (Popper, 1982*b*), I think that it has a broader applicability to systems theory in general.

Popper's concept of *propensities* differs from the statistical approach to probability in that it talks of "unobservable dispositional properties," which are also "relational properties." Moreover, if the frequency theory treats probability as a property of some given sequence, Popper views it as a property of the generating conditions. This approach allows us to deal with a probability of a single event. In addition, Popper chooses to make his calculus compatible with the frequency theory, so that ultimately it will lend itself to experimental verification.

Still, Popper did not offer any constructive procedure for computing probabilities so conceived; he went only so far as to raise the issue of the existence of such a procedure and some of its properties, as well as about its relation to the frequency theory of probability. Some constructive new procedures for computing probabilities did exist at the time Popper came out with his theory, but apparently were unknown to him. In Popper's defense it may be said that those procedures were yet general enough. By the new procedures referred to here I mean George Birkhoff's (1933) approach to measuring beauty and, especially, Claude Shannon's (1950) ideas on evaluating the strength of positions in chess.[10]

CALCULUS OF PREDISPOSITIONS

How, then, does the category of predispositions get quantified? Below I will try to set down some basic principles of an appropriate computational method, which I call the *Calculus of Predispositions*.

The reader will recall that in case of deterministic methods what one needs to describe a state of the system is to pick only the essentials from among the initial parameters, together with their valuations. These valuations are fully determined in a way that they completely and consistently integrate all the elements of the system. (Leonid Kantorovich pointedly called them *objectively determined valuations*.) By using these valuations, we can be sure that any step taken will be an optimal one, both locally and globally. The same holds true for probabilities based on statistical observation of frequinces or for optimization procedures in which the initial elements, the outputs, and the valuations are all expressed in terms of probabilities.

When neither probabilities based on statistical observed frequencies nor optimization methods of that sort are available, we have to rely on another method of representing the system, namely, dissection. Dissection, however, is a risky procedure, for it threatens to undermine a holistic view of the system.

The reader will recall that global valuations of essentials (Lagrange multipliers) present in a certain group of optimization methods, are sufficient to link all the elements of the system conclusively my means of a linear polynomial.

The new methods assume a deeper dissection of the system into its constituent elements and an integral evaluation of its various states through a linear polynomial. But how are the states to be structured or which parameters are to be selected, so that the weighted sum of them would approximate a holistic assessment of a given state? This is an age-old problem, conveyed in a maxim that "the total is greater than the sum of its parts." To solve this problem, we need a special weight (evaluative) function.

With these functions, we assume the existence of incomplete, though varyingly incomplete, valuations of individual essentials. By *essentials* I mean elements that constitute the skeleton of a state. The relations between the essentials I will call *positional parameter*, which I will discuss soon. Unlike the old probability methods, the new methods are not capable of operationalizing the determination of the least incomplete valuations of individual essentials, and, therefore, cannot reduce the system to a linear polynomial containing only the essentials and their valuations. Here we have to rely on a fairly complex procedure of evaluating the entire set of essentials that make up a state of the system.

This is, in effect, a virtual procedure. It assumes that the overall valuation of the essentials is atomized and that the unconditional part of the valuation (the part that does not depend on the current circumstances) can be "distilled" in a constructive manner. But the general conditional valuation of any given state of a system calls for augmenting the aforementioned unconditional valuations of the essentials with positional parameters. The latter are manifest in such independent variables as (a) the relations among the essentials and (b) the respective valuations of these relations.[11] Optimization procedures do not require that these relations be derived as independent variables, simply because they are implicitly incorporated into the algorithm itself. Failure to "network" all the constituent components of a system means the algorithm did not account for all the relevant relations among the essentials and their respective valuations. To address this problem, the various relations among the individual essentials must be "distilled" (made explicit) and treated as independent variables, which are assigned exogenous (with respect to the algorithm) valuations.

The uncovered relations among the essentials are applicable to the past as well as the future. The latter comes to the foreground when we measure predispositions, which is oftentimes a nonmarkovian process. This means that the initial state depends not only on the previous dynamics but also on the future course of events. I will elaborate on this point when I discuss the *relay effect*.

Thus, the probability of a certain event (state) depends on the way the state of a system is broken into individual constituent components that are subsequently integrated. In other words, the system is first split up into essential and relational parameters and their respective valuations and then synthesized in order to preserve the holistic effect.

Let me summarize our discussion on computing probabilities to this point. The representation of a system in the primary multidimensional space must in-

corporate as independent variables both the essentials as well as positional parameters; accordingly, the conjugate space features new types of variables termed unconditional (semiconditional) valuations.[12] The weight function reflecting the indeterminate nature of the state, synthesises the variables in the initial and conjugate spaces. This function, which is only partly objective, involves the *essentials* (material parameters), weighted by *semiunconditional objective evaluations*, and in addition *relational* (positional) parameters as *independent variables* with corresponding *unconditional subjective evaluations*. The development of such a weight function yield an explicit and quantitative analysis of situations, which today are regarded as pervasively qualitative and have only been subject to implicit intuitive examination.

My contribution to the quest for new methods of computing probabilities entails a generalized procedure designed to form the structure of the next step. The procedure pertains to *any system* where the need for such methods arises. The two key notions that inform my generalization are: (1) essentials and positional parameters figure as independent variables and (2) all these parameters are measured in unconditional valuations (or, more precisely, in semiconditional valuations). I have tried to highlight the distinction between the notion of *predisposition* and that of *adaptation* (or related concepts of *flexibility* and *resiliience*). From the functional perspective, the concept of predisposition parallels that of adaptation: in both cases, the key task is not so much to forecast the future, but to prepare for an unknown future. In this context, adaptation implies passive adjustment of a system to a turbulent environment. On the other hand, the creation of predispositions presumes an active interaction with the environment (in effect, shaping the environment). This subtle point informs the structural difference between the two concepts. Under adaptation, the structure of a system is based primarily on *versatile essentials*; that is, flexible elements and methods of their transformation, which allows the system to switch (adjust) from one set of circumstances to another. In forming predisposition, the essentials are treated holistically (in totality), which calls for the introduction of relational parameters that describe the state of a system.

The valuation of the system's predisposition at any given moment constitutes just one step of the general procedure, which aims to construct the trajectory of development of an indeterministic system. I know of several instances when such a trajectory was devised using empirical or semi-empirical procedures, notably the computer chess programs based primarily on exhaustive (brute force) search (Shannon, 1950), and *algorithmic aesthetics* for computer models for criticism and design in the arts by George Stiny and James Gips (1978), the index of vulnerability for strategic minerals devised by Alvin King (1981), the nonclassical analysis of the behavior of corporations elaborated by Sidney Schoeffler (1991), and so forth.

Also noteworthy is Alex Pentland's article on pattern recognition (*Face Space*, 1992). Unlike the other works mentioned above, I will not go into this work. At this point, I just want to note that the method proposed by Pentland differs from other techniques precisely in that it incorporates the valuations of individual parameters. Since assessing the verisimilitude of a given position

(state) is predicated upon a synthetic criterion that incorporates individual parameters of the system, the problem posed by the author is equivalent to the one of finding the valuation of the new position, that is, the position's impact on the future course of events.

As the article points out it may seem that "you could teach a computer to recognize a face by feeding it a digitized image, marking key references points—such as the corners of the eyes and mouth and the distances between them—that identify the face as unique" (p. 9).

But what to do if the eyes are concealed behind the glasses, or the mouth covered with a beard? The solution based on the simple set of components and their interrelations posed many problems, which Pentland proposed to overcome by inventing a new pattern recognition technique he dubbed *principal component analysis*. The cornerstone of the new method is the idea that individual features should not be viewed in isolation, because they change depending on how they combine with other features and because individual features possess different weights. Given these assumptions, the image is constructed by means of an iterative procedure based on the weighted sum total of the features incorporated into the algorithm (for instance, tapered versus elongated, light versus dark). The proposed method serves to uncover those components that are the best discriminators by first analyzing a training set of faces. After that it decides how much of each component a given face is endowed with, then combines the components to create a weighted sum—a position in a multidimensional face space—that is unique to that face.

I know of a single daring attempt (which is far from being completed) to formulate a rigorous mathematical procedure to compute predisposition. It was made by the British mathematician Ron Atkin (1972*a*). He developed a concept of connectivity and applied it to such diverse fields as mathematics, politics, military strategy, chess, regional issues, family therapy, interaction of atoms and molecule, etc. (Atkin & Johnson, 1992). In the present context, the merit of Atkin's work is finding the formal language that adequately describes his concept. The formal constructs, borrowed from algebraic topology constitute an important step in the mathematical analysis of the problem, including its application to chess (Atkin, 1972*b*, 1975). However, Atkin's concept has not crystallized into a full-fledged algorithm to solve complex problems such as chess. Unfortunately, I am in no position to pinpoint the reasons hindering algorithmic implementation of Atkins' concept. On the other hand, in spite (or perhaps due to) of the more empirical nature of the algorithm based on the aforementioned weight function elaborated by Claude Shannon, this algorithm has been quite successful giving even the world chess champion a run for his money.

So, the creation of predispositions is a particular case of computing probabilities (in the mathematical sense of the term). The two methods of computing probability—via predisposition and via frequencies—may generate similar results, especially if the predispositions-based method thoroughly interconnects the system's constituent elements.[13] Other conditions being equal, the less exhaustive and complete the network linking the elements, the more deficient will be the results generated by the predispositions-based method as compared with

the frequencies-based method. While inadequate in some respects, the frequencies-based procedures encompass all the relevant conditions and directly link a given state with the probability of a certain outcome. Assuming the outcome is sufficiently remote from the initial state, the probabilities calculated at each step of the procedure may seize to fluctuate, because the various possible configurations of the system's elements have already been incorporated into the statistics (which guides the system). By contrast, the predispositions-based approach does not generate a complete and consistent link among the constituent elements and so drastic fluctuations in the valuation of predispositions may be possible at each subsequent step. In other words, when computing predisposition it is difficult to define the contribution of a given state to the future in such a way that the current valuations remain valid for these future states.

In those instances when the probabilities and the predisposition-based methods are interchangeable (at least, in principle) the choice of either method depends on the available statistics, expenditures to gather the data, and the extent to which the system's constituent components can be interlinked.

On the other hand, there are countless situations in which the two are not interchangeable, notably in unique situations that do not yield any information as to the frequencies of the events. The only way to determine probabilities under the circumstances is to calculate predispositions. Also, one needs to exercise caution when using statistical data that features novel (meaning insufficiently tested) combinations of elements to find the probabilities distribution of the possible outcomes.

In fact, the two methods of computing probabilities may compliment each other. This can happen in two cases if we apply these methods to a multilevel system, assuming that the higher the level is the higher is the degree of composition of the objects on this level.

The first case can be illustrated by a two-level situation. On the higher level, the higher degree of composition allows to accumulate a lot of statistics, and on the basis of these statistics it is possible to find the probabilities (frequencies) of the implementation of certain actions. On the lower level, one deals with individual entities that have many features that stipulate the behavior of the entity, and the combination of these features is unique. Under these conditions, it is difficult to accumulate statistics that will be sufficient to judge the probability (frequencies) of the influence of a certain action on the behavior of the given entity. In this case, it is easier to find the set of parameters that stipulate the value of the predisposition of a certain entity to a certain behavior.

For example, if one knows from statistics that in a certain community there is a very high rate of crime, he/she will try to do his/her best to avoid interactions with such a community. If one deals with a certain person from this community, for the general reasons that have been mentioned above, the decision concerning interactions will be based on the possibility of elaborating a proper plan to deal with this person, which is further based on the evaluation of the predisposition of this person to certain types of behavior.[14]

The second case, concerning situations when the two methods of measurement of probabilities can be complimentary, is related to one level of the multi-

level system. Consider the following case of frequencies-based probabilities being used to assess predisposition: unconditional valuations of material, as well as positional parameters, are computed as averaged-out statistically defined magnitudes. However, statistical information about every component, which defines the state of a system, may be impossible in principle. For instance, the set of essentials is quite volatile, since new objects for which no statistical data are available turn up frequently. The set of positional parameters is more stable, for the relations are more stable over time and there are ample statistics to describe their behavior. The problem here is to uncover and evaluate them.

Our "compare and contrast" discussion of chess (where the number of pieces is fixed) and the economic system (in which new products do appear) illustrates the theoretical point made above.

The following should also shed some light on the interplay between the frequencies-based probabilities and probabilities based on predisposition. Frequencies-based search method may ignore the mode of representation of the initial state, that is, whether the initial state is described via initial or dual (conjugate) parameters. In other words, frequencies-based probabilities bridge certain events. The influence of the initial state upon the outcome and the likelihood probability of this impact are fused or implicitly incorporated into the probability of the outcome. When probabilities are computed via predispositions, it is critical that the initial state of the system be represented via the synthesis of a set of conjugate parameters. In effect, predisposition measures the impact of a given event upon the future. The extent to which frequencies-based probabilities of essentials and relational parameters are employed in this predisposition-based procedure has already been discussed. Assessing the likelihood of this procedure calls for testing, that is, a frequencies-based approach. The predisposition-based procedure fails to link a given state with the outcome.statistically. As the procedure (especially relational parameters and their conjugate parameters, i.e., valuations) is tested time and time again, its reliability can be measured based on the statistical distribution of the results.

To sum up, frequencies-based approach features a one-step procedure for finding probabilities. Predispositions-based method incorporates a two-step procedure: assessment of the impact of the initial state as well as the likelihood of this impact. Statistics has a role to play in finding the probabilities of events (for both methods) in so far as each method relies on the frequencies based approach.

My last point on the subject of predispositions has to do with terminology. Strictly speaking, creation of predisposition is akin to a non-statistical (not frequencies-based) method for computing probabilities. My choice of the term *calculus of predispositions* spotlights certain aspects that are not captured by the generic term "non-frequencies-based method" (which might include other methods of computing probabilities). Also, the term I picked evokes many other rather unrenowned phenomenon that crop up in many different areas. The term *calculus of predisposition* is of heuristic value as well, since it links the category of predisposition with our intuitive notions of certain phenomena that beg to be interpreted as predispositions.

The intuitive notions I have in mind are rooted in the category of beauty, to which I have devoted many pages of this book. It is extremely difficult and cumbersome to try to link the category of beauty with probabilities in the abstract mathematical sense of the term. Let me use this opportunity to qualify my previous treatment of the aesthetic method, its leading category of *beauty*, and the concept of predispositions. I linked these categories based on the rather general logical and structural features (in fact, more static than dynamic), which they share and which are assessed based primarily on rationally defined valuations. I had omitted the artistic devices that enrich the predisposition that is beauty. Feelings were also omitted from the process of evaluation. In this book, I shall try to remedy these flaws by portraying beauty as a much richer category.

In concluding this brief analysis of the interplay between the categories of probability and predisposition, I would like to discuss the role of individuality versus uniformity and subjectivity versus objectivity. I shall examine these dualities in the context of predispositions and then in the more general framework of probabilities.

The evaluation of predisposition raises some difficult issues regarding the implementation (follow up or continuity) of this assessment using uniform and objective methods. My thesis in a nutshell is the following: while the set of essentials and their valuations (particularly semiconditional valuations) can be *objectified* and made *uniform*, the set of positional parameters and their valuations is largely *individualized* and *subjective*.

Figure 1.2 presents a systematic overview of the possible combinations of the various parameters that enter into the valuation of a chess position. The text that follows expands on the individual cells.

Figure 1.2
Features of an Object and Search Methods

Object's parameters	Degree of uniformity of the methods					
	Individualized			Uniform		
	Tested			Degree of tested		
	Full	Partial	Zero	Full	Partial	Zero
Initial						
Conjugate						

First, I want to comment on two critical dualities highly relevant to our discussion: individuality versus uniformity and subjectivity versus objectivity. My goal here is not so much to present original ideas as to render them in a systematic manner.

INDIVIDUALITY-UNIFORMITY, SUBJECTIVITY-OBJECTIVITY

As I noted above the creation of an entity by a demiurge (as well as the perception of the process and the result of creation) requires that the object possess three kind of parameters: *initial* parameters and *conjugate* ones (valua-

tions, which reflect the forces acting on the object—i.e., the object's significance); the latter, in turn, are either *local* or *global*. There are individualized as well as uniform methods of defining these parameters. The role of science is to make them objective. Consider the following trivial example of such initial parameters as the amount of salt in some product. It is up to each individual to determine the saltiness of the food based on his own taste; science, by contrast, finds ways to make a objective judgment using some device to gauge the variable and arrive at the same result.

Things turn murky when it comes to assessing the value of a product. The amount of positive or negative feelings associated with the same amount of salt in a product is individualized for each subject and uniform assessment is impossible. On the other hand, the product's price—this global parameter of an economic field —is uniform for all the participants.

So, the process of creation features both individualized as well as uniform methods of elaborating initial as well as conjugate parameters, but neither method guarantees an optimal solution[15] and leaves room for improvement. There is room to express one's individuality (even for computer) by manipulating the first-level program, that is, a program that changes the zero-level (behavioral) program. A particular case of a second-level program is a learning program based on the performance of the first-level program.

If we extend the notion of a program level (to include higher-level programs), uniformity can be achieved if an optimal solution exists or if there is uniformity of any level program.

In constructive terms, the difference between individualized and uniform assessment comes to the fore when we try to isolate the operator (one assessing the position) from the one who has to follow up on it (execute it). When assessment is individualized, the one doing the assessment is inexorably linked to the one doing the implementation. By contrast, uniform methods of assessing a position allow anybody (with some qualifications) to attain the same result. This issue will again come up when we look at subjectivity versus objectivity.

Individualized as well as uniform methods of assessing a position can be duplicated to a degree (ultimately, even *formalized*). Subjectivity and objectivity reflect the degree of reproducibility of the result. Subjective assessment implies that the operator (one assessing the position) has no explicit clear-cut knowledge of his method and so it cannot be duplicated by anyone else (often times, including the operator himself).[16] Subjectivity with regard to positional parameters is informed by the fact that these parameters are formulated and assessed by the players themselves who are often times unable to formalize their thought processes.

Within an objective framework, the evaluation procedure can be repeated with the same result by any properly trained subject.

An objectivized method of assessment is not always deterministic; it might be indeterministic, that is, avoidable. Other conditions being equal the key quality of the objective method is that it be precise enough to be duplicated with the same result by anyone.

Ultimately, *subjectivity* implies that these *imprecise* methods are the only means available to a given participant to find the attributes of a position; by contrast, *objectivity* entails discovery by *known* methods. Subjectivity in formulating and assessing positional parameters comes to the fore when the "operator" not only is unable to formalize his method but even duplicate it himself.

Now let us place the notions of subjectivity and objectivity in the context of general systems theory.

From the *functional* point of view, subjectivity versus objectivity shows the plausibility of constructing a reproducible method of assessing a situation. From the *structural* perspective, this duality is manifest in the possibility of *existence* of an object independently of an observer. From an *operational* standpoint, the problem entails the formulation of precise and all-encompassing information (ultimately, a formalized procedure) needed to create (reproduce) an object. From the standpoint of an *operator*, subjectivity versus objectivity concerns the possibility of *detaching* the creator (reproducer) of the object (method) from its subsequent implementation. In terms of *genesis*, the above duality pertains to finding the source of *experience* in assessing the object, that is, whether this experience is limited to the operator or is accessible to anyone.

Our discussion of subjectivity/objectivity and individualization/ uniformity informs a more general notion of the structure of predisposition. Let us note that the component of the structure of predisposition, which has to do with essentials, can be largely objectified and uniformed with regard to both initial and conjugate parameters. By contrast, relational parameters are largely individualized and subjective, both with respect to initial parameters as well as their valuations.

What epitomizes the individuality of any given agent (participant) is his unique approach to selecting from among the already known relational parameters as well as inventing new ones. Also, since the future course of events is unknown, it is critical that the participants recognize their personal ability to follow up on the predisposition offered by the situation. Subjectivity in the choice and evaluation of relational parameters reflects the fact that the participants do not fully comprehend their method, since there are no complete (particularly, no deductive) methods for formulating relational parameters.

This brings us to the so-called *relay effect* and the notion of continuity. It embodies the idea that the predisposition attained by one participant must be continued (taken over) and developed by another. This other participant may have his own personal vision of the system's predisposition, but to ensure continuity, he must take into account the approach of his predecessors. In a relay race, the runner who gets the baton must not only judge the predisposition of the current situation (the other runner's strength, sequence, etc.), but must also observe the race as it unfolded (i.e., judge the strength of the runners and the relations among them).

The relay race may prove unworkable if the subjective factor is highly pronounced. For instance, collaborative creative effort in poetry, music, and, to a large extent, in painting is uncommon. In these areas, relay type collaboration is usually reduced to finishing the work started by the now deceased (the work is

usually completed by someone familiar with the ideas of the original creator). For instance, Borodin's opera *Prince Igor* was largely completed by Nickolai Rimsky-Korsakov and Alexander Glazunov. Both had extensive communication with the deceased and understood his game plan (Calvocoressi, 1944).

However, in many areas, including the economic system, the duration of the process precludes the creator from completing the work, so continuity between the creator and the successor is essential (even if the former was a sole owner). Here, the choice of the new leader is a complex process, which must take into account the new leader's ability to link the past, the present, and the future (for example, whether to follow the previously tested course of development or break with traditions and embark upon anew strategy).

Let us now look at the interplay between subjectivity-objectivity/ individuality-uniformity and the category of probability in the most general sense of the term. To avoid repetition, I will limit the discussion to a well-known category such as subjective probability (or Bayesian, as they popularly called) founded by Frank Ramsey and followed by Bruno de Finetti, Irving Good, and Leonard Savage (Smithson, 1989). Henry Kyburg and Howard Smokler (1964) define subjective probabilities in a following way: "In the subjectivistic view, probability represents the *degree of belief* that a given person has in a given statement on the basis of given evidence" (p. 7).

The notion of subjective probabilities raises two issues: the axiomatic foundation and the methods underlying the intuition of the agent who assesses the probabilities.

Axiomatic tenets derive from ordering the degree of belief, that is, establishing coherence (consistency) as well as exchangeability. This means, in effect, that the next event is not independent and its probability hinges upon some previous events. Rather than dwell on subjective probability, I refer an interested reader to the introduction to the book edited by Kyburg and Smokler.

For our purposes, I would like to focus on the methods of computing the degree of belief, which informs the intuition of the subject assessing the probabilities. Three assumptions are plausible in this regard: (1) degree of belief in a given statement is rooted in frequencies-based probabilities, which are, in turn, predicated upon the time-tested experience of the subject; (2) by abstracting from secondary attributes the statement can be reduced to another statement that has been extensively, albeit subjectively, tested; (3) one actually computes predisposition rather than frequencies-based probabilities, but disguises the former as the latter.

I believe that the last two cases often appear under the guise of subjective probabilities. Inadvertently, intuition-based reduction of one statement to an analogous one is accepted without explicitly questioning the significance of these neglected secondary attributes. In effect, what one may be doing is intuitively computing the predisposition of a given statement while portraying it as frequencies-based probabilities. It would be interesting to put together a questionnaire to uncover the intuitive notions that inform the decisions made by one acting based on subjective probabilities. In any event, subjective probabilities come in handy in forming predisposition.

The immense potential of personal intuition to assess different parameters can, in principle, be formalized and used to guide the process of formation of the valuations. This does not preclude the magnitudes of these subjective valuations from being determined in a subjective fashion.

Some provocative ideas and methodology designed to accommodate assessments based on subjective judgments have been developed by Thomas Saaty (1996). He termed the procedure Analytic Network Process (ANP). The main focus of the book is the search for an objective solution based on the subjective valuations provided by the set of individuals (experts) partaking in the decision making process.

> Science and reason improve our understanding of who we are and in what kind of environment we live. But the facts and understanding we obtain through science and reason are fundamentally related to our values and needs and to the judgments which serve our values. Because values and judgments vary among individuals, we need a new science of judgments and values to help us achieve universality and objectivity. Then we will be able to understand, cooperate, survive, and fulfill ourselves. (pp. x-xi)

When we have one participant and one method of implementation this procedure degenerates, that is, it turns into a technique for structuring the decision-making process in a hierarchical fashion.

ANP can be used to assess the development of uncontrollable objects, that is, to forecast their behavior. A similar technique can be used to select the experts and assign weights to them.

ANP applies to socioeconomic and political situations featuring collective decision making and where the function of the executor of the collective will is limited to the implementation of the respective decision. In effect, Saati's work aims to develop methods of optimal objective decision making for situations where the system’s elements are integrated via the participants' ability to form and evaluate the respective parameters. Factors that inform one's intuition and are vital to assess the degree of conditionality of the valuations assigned to the various parameters falls outside the scope of ANP.

By contrast, the concept of predisposition spotlights situations featuring subjective valuations of the position. Subjectivity stems from the fact that the valuation is inseparable from the one doing the implementation of predisposition thus formed. Moreover, the notion of predisposition seeks to validate the need to employ both subjective and objective valuations of varying degree of conditionality, which, in turn, defines the system's predisposition toward development.

The person making a subjective decision aimed at creating predisposition may actually benefit from the use of the valuations provided by the colleagues and experts (if only to double check himself). Thus, ANP and the concept of predisposition turn out to be complimentary.

In summary, the category of determinism, as rendered in this chapter, is characterized by the inevitability of the events. There is an important distinction between indeterminism and other related phenomenon, such as uncertainty, which describes the knowledge of a system. For instance, in quantum mechanics the terms *indeterminism* and *uncertainty* are used interchangeably, which fails to underscore the distinction I want to make.

Current philosophical literature on the subject is dominated by a binary notion of determinism-indeterminism, while the conception expounded in the book suggests that this category yields to measurement (degree of indeterminism)

The spectrum of indeterminism incorporates many phases. My analysis focuses upon the phase dedicated to the creation of predispositions. In its mature form, the category of predisposition is analogous to beauty, or, in Immanual Kant's words, it is "purposiveness without purpose."

Our discussion of the link between the categories of indeterminism and predisposition focused upon a relatively unexplored method of computing probabilities via the system's predisposition. I also touched upon the application of this concept to the various fields of human endeavor. This method needs to be pursued further and it is still awaiting its patron.

From this point of view are provocative the postmodern choices of criteria for selecting axioms, guiding creative activity, and deciding the legitimacy of truth-claims. As Michael Smithson (1989) mentioned, these postmodern choices

> include, of course, the classical schools amongst the options. But for the nonclassicists, the determining criteria tend to be either utility or aesthetics. If we cannot attain absolute certainty, then at least mathematics should be useful in applications (the 'applied' point of view) or beautiful to behold (the 'pure' viewpoint). (p. 38)

Perhaps, these statements somehow are connected to the call issued by an outstanding twentieth-century mathematician Israel Gelfand to develop a new kind of mathematics.

In Israel Gelfand's 1989 lecture in Kioto, when he was awarded the Kioto Prize in Basic Sciences (Gelfand, 1991), he spoke about two archetypes inculcated into the human psyche and the link with mathematics. The first archetype asserts that "Man is the supreme achievement of the evolution—the crowning jewel of creation." The second archetype states that "Man is part of all of Nature and cannot detach himself from Nature." These two archetypes inform our perspective on things; for example, in reproducing a faithful portrait of a murder suspect. "We can ask some adequate questions, after which we can draw and even recognize the person. This is clearly a much better way to proceed than trying to take the coordinates of the person's whole head" (p. 14).

Each discipline calls for its own language to express the content of the issues it raises. Perhaps, it make sense "to resist the dangerous and careless use of exact mathematical and logical systems outside the domain of their applicability." Gelfand contends that new ideas must come from mathematics. He mentions two: "One is a radical shift in the concept of space, quantum gravitation,

and the like. The other emanates from the ancient field of combinatorics, which is still lurking in the backwaters of mathematical sciences" (p. 16).

Gelfand also spoke about the need to elaborate a universal language—a language that will allow us to understand the duality of the two archetypes, help reconcile the two and bridge the void fraught with so much pain and suffering for mankind.

NOTES

1. Theoretically, this is true not only of a future path of the system but also of its past. History as a science is particularly sensitive to changes in the political mechanism, as George Orwell brilliantly showed in his book *1984*. I may also point to a popular Rus-sian joke to the effect that Russian history is totally unpredictable.

2. The notion of potentiality and actuality are frequently denoted by ontology and epistomology respectively. Marshall Kavish (Katsenelinboigen and Kavesh, 1986) calls potential and effective determinism metaphysical and epistemological, respectively.

3. Laplacean approach to the nature of the universe exactly feeds the statement that determinism—the fixed law of motion—is strongly connected with certainty: "An intelligence knowing all the forces acting in nature at a given instant, as well as the momentary positions of all things in the universe, would be able to comprehend in one single formula the motions of the largest bodies as well as the lightest atoms in the world, provided that the intellect were sufficiently powerful to subject all data to analysis; to it nothing would be uncertain" (Quoted in Earman, 1986, p. 7).

4. As Werner Heisenberg (1958), one of the founders of quantum mechanics, mentioned: "One could speak of the position and of the velocity of an electron as in Newtonian mechanics and one could observe and measure these quantities. But one could not fix both quantities simultaneously with an arbitrarily high accuracy. Actually the product of these two inaccuracies turned out to be not less than Planck's constant divided by the mass of the particle. Similar relations could be formulated for other experimental situations. They are usually called relations of uncertainty or principle of indeterminacy" (pp. 42-43).

5. Some physicists go beyond Heisenberg, the author of uncertainty/ indeterminacy principle in quantum mechanics. Murray Gell-Mann (1995) writes:

> ...quantum mechanics introduces a great deal of indeterminacy, going far beyond the rather trivial indeterminacy associated with Heisenberg's uncertainty principle.
>
> Of course, in many cases the quantum-mechanical probabilities are very close to certainties, so that deterministic classical physics is a good approximation. But even in the classical limit, and even when the laws and initial condition are exactly specified, indeterminacy can still be introduced by any ignorance of previous history. Moreover, the effects of such ignorance can be magnified by the phenomenon of chaos in nonlinear dynamics, whereby future outcomes are arbitrarily sensitive to tiny changes in present conditions. (p. 18)

Some physicists believe that the uncertainty principle in quantum mechanics can be overcome, and that the system can be made deterministic (in the traditional sense of the word) through a new theory of the physical nature of particles based on their long-range interactions. An interesting survey of this approach is contained in Josephon & Pallikari-Viras, 1991.

6. Equating *rules* with *transformation methods* might be a little confusing because it conflicts with widely accepted conventions. In language systems, for example, *rules* are equivalent to *performance method*s, whereas in chess they correspond unambigiously to *fundamental methods of transformation*.

7. Punishment for the crime committed does not make any sense if the individual is incapable of changing his behavior. More precisely, an individual held to be a criminal must merely be isolated from the environment since he poses danger to it. All attempts to remodel a person by means of punishment should in this case be deemed futile. On the other hand, by assuming free will, the administration of punishment (i.e., making more severe in the mind of the individual the society's negative judgment of certain acts), one can try to modify the person's behavior. In other words, one can try to achieve a change in his behavior *post factum*. The other implication of free will is that punishing certain individuals helps inculcate in the minds of others the knowledge of the negative judgment pronounced by society on certain types of behavior. This is a preventive approach to fighting crime, that is, action before the fact.

8. A country's military defense mechanisms fit into this scheme. A country may possess a military force capable of destroying any attacking force; or it may be surrounded by impenetrable walls (in the past natural barriers such as water bodies and mountain ranges); finally, the country may be able to assimilate the aggressors within its own culture (this was characteristic of India at certain periods of its history).

9. A detailed discussion of various ways of representing the economic system and of the relationships between different representations, can be found in chapters 5-7 of my book (1992 *b*).

10. This is also a possible perspective from which to view those theories in physics in which a physical system is emplaced in space having more than four dimensions. As far back as the 1920s, Theodor Kaluza and Oscar Klein worked on physical models having five, eleven, or other multiple dimensions.

Present-day superstring scholars make use of a ten-dimensional space to bring together all physical phenomena within the general field theory. But it should be noted that "while all other successful theories of physics have been built on some brilliant revelation about the underlying physical behavior of the universe—the uncertainty principle in quantum mechanics, for instance—string theoretists have had no such vision or understanding, only equations." (Taubus, 1995).

The reader should be aware that the Big Bang theory is an *evolutionary* (in a temporal sense of the word) variation of the general field theory. The Big Bang theory suggests that those stages of evolution for which there are not enough data to draw frequency estimates are perhaps best studied from the standpoint of propensities or predispositions. If this idea makes sense, it may be possible to regard dimensions above the fourth as variegated relations between objects that emerge in the course of their interactions and that cannot yet (or ever, due to the nature of things) be directly connected with each other.

11. Relational parameters are more enduring than the essentials. Consider social systems. Here it is appropriate to recall the famous Russian writer Mikhail Zoshchenko. In 1935, the middle of the dark days of the 1930s, in a country that claimed to be changing human nature, he wrote a courageous book about the immutable nature of mankind.

Describing in his book all kinds of failures in the lives of people in the past, Zoshchenko writes:

> Of course, we were taking about past centuries and eras. Some prime ministers, from their arrogant European point of view, might get irritated with us and ob-

> ject. They'd say that was the uncivilized past, while in our time the picture is different. Please don't confuse the two.
>
> But nevertheless we do confuse the two, since we see before our eyes approximately the same glorious picture as we do when we open our history books.
>
> Paupers wander the streets. People suffer from syphilis. War rages. Someone's mother cries. Someone's head is hacked off. The rich don't let the poor eat; grain is dumped into the sea to keep the price up. A bride suffers. A groom returns without a leg. Books that a fascist regime finds inconvenient are burned. ("The Koran contains everything.") Someone is tortured...and then thrown into prison. People are beaten with rubber truncheons. The poor man laments his plight, while the rich man amuses himself dancing the Charleston.
>
> Honestly, gentle prime ministers, the failures are almost the same.
>
> Perhaps the only thing we have learned is to drive faster along the roads. And We shave now. And we can listen to the radio. And we've begun to fly almost up to the heavens. In general—technology.
>
> But with respect to our relations toward each other, things have changed very little. And no matter how sincerely we would like to see something unusual in this, we can't. But gentlemen, don't be angry. Of course, there is a certain moral improvement. For example, we don't have public executions, although couldn't this be, perhaps, because we lack the nerve?
>
> As for the fact that some writers are buying themselves villas on the Mediterranean, well, this was the case before, as well. For example, a person who had no quarrel with the Pope could live quite decently and die with high honors.
>
> But all the wonderful words about technology—the idea that it has improved relations between people—these words are not justified by the facts. One must admit this with sadness. (pp. 252-253)

Regarding his comment about the Koran:

"In the eighth century the Arabs conquered Egypt and burned the marvelous, world renowned library in Alexandria. Over the course of several months, this library was used as fuel to heat the city baths. The commander who gave the order to burn the library said, "Everything is contained in the Koran" (p. 249).

12. The concept of "actual space" has a long history. One theory goes back to Leibnitz who thought of space as constructed upon a set of relationships among objects. Assuming objects themselves represent undifferentiated elementary units, they, in effect, form a kind of cluster of relations. The other approach to actual space dates back to Newton, who thought of actual space as being absolute and containing real objects.

13. This sounds similar to a problem in quantum mechanics concerning the probability of a particle appearing. The probability is computed based on statistics or Erwin Schrödinger's equation that incorporates Planck's constant. (Could the constant be an analog of the aggregate influence of relational parameters?) The method used to measure predisposition in quantum mechanics is relatively simple: the pair of variables that describe the state of a system (in this case particles' coordinates and the impulse) is quantified in a single step, but with sufficient accuracy to ascertain the inevitability of the particle's trajectory. In more complex cases, it is impossible to determine the magnitude of this pair of variables directly, and so we have to resort to more complex procedures for integrating the system's elements.

14. Vera Zubarev very wisely applied this concept to the analyses of behavior of

Romeo—one of the major protagonists in the famous play by Shakespeare, *Romeo and Juliet*.

15. Here *optimum* implies some predefined outcome or criterion of optimality; it means that no better result (or *min/max*) can be attained. This principle comes to the foreground if there is a goal that embodies the final state. While there may exist more than one path toward the same final state (equifinality), the notion of optimality bears a strong mark of individual assessment.

16. This factor might be behind the problem of assessing the performance of the extrasensory perception.

2

CHESS

There exist many types of chess games, which differ with respect to such parameters as the size, the configuration, and the dimensionality of a chessboard; the number and types of pieces; and the rules of piece interaction. It appears that each version of chess best models a particular situation.

The common version of chess, especially used in the West, has many applications. Its applications to societal systems are mentioned in the next chapter. John Ewen (1997) used the chess analogy for creation syndiotactic polymers.[1] There are situations when the modifications of the regular chess game are critical. For example, the recent concept of the creation of large-scale structures in the universe presumes that "the whole distribution [of superclusters] resembles a three-dimensional chessboard" (Einasto, at all, 1997).[2] Perhaps, a game played on such a chessboard can provide clues about the performance of the universe.

For the purpose of this book the relatively simple and widely accepted version of chess on a two-dimensional, 64-square board will suffice.

This game of chess is an excellent illustration of the concept of predispositions. While chess is not exclusive as a model game, my choice is dictated by the following considerations: in spite of its relative simplicity (see the chapters on predisposition as it pertains to societal and economic systems) *chess* is a game, which, unlike *Go*[3] or *checkers*, features *heterogeneous* elements; and unlike *backgammon* or *poker* (McDonald, 1950), the role of *chance* is reduced to nil;[4] there is a *temporal dimension* to chess since *linking the game's initial position with its end in a complete and consistent manner* has proved elusive (unlike *tic-tac-toe* or *checkers* played on an 8x8 board).[5]

My investigation into the game of chess will stick to the game as such, meaning the factors involved in winning a series of games (which is typical of tournament play) are dropped from consideration. The point is that the rules governing a given game are fixed and extremely conservative (they have stayed unchanged for centuries), while tournament rules are flexible and subjective de-

cisions made by tournament organizers can affect the final outcome. For instance, during the last decade chess fans have witnessed frequent changes and manipulation of the rules by the International Chess Federation in conjunction with the World Championship matches with Anatoly Karpov, Victor Korchnoi, and Gary Kasparov.

The conservative nature of the rules (they are simple, well defined, and can be easily observed by the players or the referees), and the fact that chess is a finite game (as far as the total number of variations), suggests that chess can be completely ordered.

In short, *potentially* chess is a deterministic system. However, it is not clear whether this feature of the game can be *operationalized*. In view of the astronomical number of possible variations (of the order of 10^{120}), chess does not yield to an *exhaustive search* even if the search is conducted by the most powerful computers. The only approach that will make chess operationally deterministic is an optimality (*max-min*) algorithm that generates an optimal move for each side at each stage of the game. What this approach implies is that in terms of the final outcome no better move than the one selected by the algorithm exists. So far, no such algorithm has been devised; in fact, its *existence* has not been proved, to say nothing of constructive implementation.

In view of these limitations, chess still belongs to the realm of indeterministic systems. Chess lacks a completely ordered search procedure and the consequences of a given move (its impact on the course of the game) are generally unknown—in Hamlet's words "*the time is out of joint.*" Still, over the course of 1,500 years chess players have made tremendous. The history of chess has proved repeatedly that there is no single exclusive approach to solving the enigma of the game. Players have developed a variety of methods to arrive at satisficing solutions at the various stages of the game (opening, middlegame, and endgame) as well as handle certain types of situations that arise within these stages, notably combinational and positional styles of play in the middlegame or pawn endings in the endgame. Also, highly non-trivial methods of integrating the various methods of play have been elaborated.

There exist a number of alternative ways to classify the diversity of the methods of play employed in chess. Let us examine two approaches pertinent to our subsequent discussion.

In terms of *choice*, these methods can be grouped into two broad categories. The first one includes *reactive* type methods based either on the moves made in the past or on *heuristics* (*rules of thumb*). The second group includes *selective* methods based on the search for the best move. The latter methods are more prevalent, if only because new unexplored positions do arise and the number of heuristics which can be linked in a consistent manner is rather limited.

From the standpoint of the *possible impact* of a given state upon the outcome (terminal position), the methods of play can be classified as *complete* and *incomplete*. Complete methods imply a complete and consistent chain linking the various positions and eventually leading to a terminal position. Incomplete

Figure 2.1
Combinations of Methods of Play: Choice and Completeness

Choice	Completeness	
	Complete	Incomplete
Reactive	Fool's mate	Openings
Selective	Optimization-driven endings	Combinations, developing a position

methods denote methods that fail to ensure a complete link between the various positions. In the general case, neither selective nor reactive methods yield a complete and consistent link between a given position and the terminal position.

The combination of the first and second groups of methods generates four alternatives shown in the Figure 2.1.

Apart from the trivial case of fool's mate, an example of completely reactive methods are techniques employed in well-analyzed (based on past experience) endgames, which usually feature small number of pieces.

An example of an incomplete reactive method are openings that have been scrutinized in a vast amount of chess literature, which has been incorporated into computer programs via the so called *opening libraries*.[6]

Examples of complete selective methods are optimization and exhaustive search techniques employed primarily in the endgame (especially endings with a small number of pieces). Theoretically speaking, the exhaustive search methods work for endings with no more than five or six pieces. An exhaustive search for any five pieces was first implemented by Kenneth Thomson of Bell Laboratories, reversing several established notions regarding certain types of endings. For instance, the procedure revealed a win for a king and queen versus king and two bishops, which was previously thought to be a draw. An exhaustive search involving six pieces (including two kings and any other pieces except for pawns) was conducted by Lewis Stiller, a graduate student at John Hopkins University. His findings also modified chess theory's long-standing claims regarding certain piece configurations. For instance, it was assumed that there is no win (assuming optimal play from both sides) under certain initial positions of the whites king, rook, and bishop versus black king and two knights. Stiller's program proved the theory wrong by discovering a winning variation on move 223—result far beyond the capacity of human players (Ross, 1991).

Incomplete selective procedures are manifest in the various combinational and positional methods of play.

Let the starting point of my analysis be two subsets of incomplete selective methods known as *combinational* and *positional* methods. Michail Botvinnik (1987) writes:[7]

> The Italian school of chess (particularly Gioachino Greco) introduced into the chess praxis a combination as a potent tool of the master's algorithm. The list of the great masters of a combination includes

> Anderssen, Morphy, Alekhine, Tal', Fisher, Kasparov.... But Greco was certainly the first! The positional component (p) was introduced into the masters' algorithm by Philidor, Steinitz, Capablanca, Karpov and perhaps the author of these lines. (p. 255)

Following this brief preamble, let us qualify that statement regarding operational indeterminacy of chess. *In actuality* chess is a mixture of deterministic and indeterministic methods of play with the latter predominating. Deterministic techniques are limited to endings, which are amenable to a complete and consistent link, achieved by means of an exhaustive search or optimization techniques.

The key component of any indeterministic procedure is the evaluation of a position. Since it is impossible to devise a deterministic chain linking the intermediate state with the outcome of the game, the most complex component of any indeterministic method is assessing these intermediate stages. It is precisely the function of *predispositions* to assess the impact of an intermediate state upon the future course of development.

Predispositions also figure prominently (almost by definition) in the positional methods of play, based on an exhaustive search aimed at selecting the best position generated by the search. Positional play, which involves a strategic plan, meaning the goal is to attack the king, and a goal of a given stage is defined as a prime positional parameter or a complex composition of positional parameters (strong left flank, security of the king, etc.), must still address the overall evaluation of the position at a given stage of the game, to avoid attaining the goal to the excessive detriment of other parameters.

The described technique is typical of combinations aimed at winning the targeted material and which do not end with a terminal position. Failure to respect the overall position, which emerges at the end of the combination, is a trap set for the opponent who might have undertaken a positional sacrifice. Moreover, preoccupation with winning the material which is characteristic of combinational play, obscures the analysis of the resulting position.[8]

Typically, openings utilize reactive methods of play, but the evaluation of the position at the end of the opening variation must be covered to prevent the opponent from gaining positional advantage. These valuations are particularly crucial in new openings, which emerge occasionally in spite of the extensive analysis of the opening stage of the game. Positional valuations also contribute to the development of heuristics, which are also part of the reactive-type methods. Take, for example, the rule advising not to make consecutive moves with the same piece in the opening. The rule works well in the great majority of cases, although the transgressions may produce beautiful results (as was shown, for instance, by the great Alexander Alekhine). This heuristic reflects the fact that the valuation of the position after consecutive moves by the same pieces actually diminished in the great majority of cases. Instead of comparing the valuations of the generated positions, this heuristic substitutes a simple binary rule governing consecutive moves made by the same piece. The rarer the exception to the heuristic, the more justified its use with the exceptions treated as special cases. The notion of heuristic has general implications, since many

systems, particularly social systems, yield valuations covering the specific actions rather than positions (or states of a system).

To sum up, whatever method of play is selected, the key ingredient is the valuation of the position. As Alexander Lysenko (1990) mentioned, William Steinitz's great feat was to conceptualize the key role of positional evaluation. He showed the way to improve one's position, something that was previously accomplished mainly on intuitive grounds. The formation of a position as a "fundamental and universal principle may be encapsulated into the following dictum: a superior plan is invariably based upon positional valuation. To evaluate, to judge, to assess is certainly not synonymous with exact knowledge. But an estimate, a judgment, or an evaluation, though not precise, is, according to the principles laid down by Steinitz, still an effective guide for the master" (p.190).

Interesting in this connection is a comment by an outstanding chess player Richard Reti (1981). He wrote that Anderssen**,** Blackburne, and Zukertort were more gifted than Steinitz. They suffered defeat at the hands of Steinitz because of the profound positional theory which he elaborated. This theory laid the groundwork for a comprehensive evaluation of a position.

Chess players employ a wide range of evaluations which vary in the degree of precision.

A state of a system can be calibrated using an ordinal or a cardinal axis. In evaluating a position, chess players employ the entire range of evaluations. Under the ordinalistic approach, one type of position is said to be better than another, but the difference is not quantified. In case of a dichotomy, the *ordinalistic* evaluation is encapsulated in such expressions as "white's position is superior" (as opposed to "black's position is inferior"). If rank is introduced, the evaluations are expressed via such linguistic variables as "bad position," "unclear position," "good position," "excellent position," etc. Theoretical treatise on chess make extensive use of these terms, which even have a corresponding semiotic system: +- denotes "white has decisive advantage;" ± "advantage for white; + "with minor advantage for black," etc. Let me reiterate that in the above case, the valuation or preference for one position over another is not quantified. The other category of valuations is *cardinalistic* and the numbers refer to rather valuations of compositions. Igor Bondarevsky (1973) has proposed a rough number scale (0 to 10) to calibrate chess positions (see Table 2.1).

In many respects chess is invaluable, for it yields the greatest accuracy in quantifying the valuation of a position.

Table 2.1
Approximate Valuation of Positions

5:5	- chances are equal	**5:5**	- chances are equal
6:4	- white is better	**4:6**	- black is better
7:3	- advantage for white	**3:7**	- advantage for black
8:2	- strategic win for white	**2:8**	- strategic win for black
9:1	- technical win for white	**1:9**	- technical win for black

10:0 denotes victory.[9]

The crowning achievement of the cardinalistic approach is the weight function developed by Claude Shannon. We still have not devised an algorithm-based formation of the wide spectrum of parameters and their valuations included in the weight function, that is, a formal link between the various methods of positional valuation and actual game strategy. Let us examine the cardinalistic approach to assessing a position based on Shannon's weight function.

FORMING A POSITION

In order to quantify the evaluation of a position we need new techniques, which I have grouped under the heading of *calculus of predispositions*. This calculus is based on a weight function, which represents a variation on the well-known criterion of optimality for local extremum. This criterion incorporates material parameters and their conditional valuations.

The following key elements distinguish the modified weight function from the criterion of optimality: (1) First and foremost, the weight function includes not only material parameters as independent (controlling) variables, but also positional (relational) parameters. (2) The valuations of material and positional parameters comprising the weight function are, to a certain extent, unconditional; that is, they are independent of the specific conditions, but do take into account the rules of the game and statistics (experience).

While chess material is finite and, in fact, rather limited (as defined by the rules of the game) positional parameters are arranged by the players themselves. At this point, no *deductive* theory to generate positional parameters exists. The number of positional parameters seems almost infinite or, at least, incomparable greater than the number of material parameters.

Let me say a few words about the structure of positional parameters. Positional parameters that denote the relations among several pieces or between pieces and squares could be termed *chunks*. Chunks are not the same as aggregates, which are simply groups of pieces sharing some common characteristic (such as heavy pieces).[10] Chunks can be represented by means of simple elementary structures, which define the relationship between two pieces or between a piece and a square with which it interacts (or squares with which they interact). Doubled pawns or a rook on an open file are examples of rudimentary chunks. More complex chunks encapsulate the interaction as among several

pieces as the pieces and the squares. A backward pawn and a flank are just two examples. The chunk's complexity depends largely on the operator. In case of human beings, the chunk's size is limited to several pieces (Simon, 1979). Several chunks grouped together form a gestalt.[11]

Today's chess programs utilize only *rudimentary* elementary chunks, omitting complex chunks such as the position in the center or at the flanks, piece(s) limited to some restricted area of the board, and so on. Computer chess programs also make light use of the idea of *abstraction*, that is, dismissal of the so called *minor elements* during the initial assessment of the position with subsequent integration of these minor elements in the final valuation.

To be effective, chess algorithms will need to incorporate the notions of *abstraction*, "*chunkinization*," and *aggregation* as well as their counterparts: *specification*, "*dechunkinization,*" and *disaggregation*. The term positional parameter (unless stated otherwise) shall denote primary positional parameters (the degree of abstraction, *chunkinization*, and aggregation is basically ignored).

Let us look at the process of valuation of mainly material and positional parameters. The first distinction concerns internal versus external valuation is that of the king (capturing the king is, by definition, the objective of the game). Internal valuations of material parameters all emerge during the course of the game. Here, the king, just like any other piece, is assigned an internal valuation. Given the rules of the game, the only valuations applicable to positional parameters are internal valuations. However, it is possible to devise chess rules under which the pieces as well as the positional parameters acquire external valuations; that is, the result depends not only on capturing the opponent's king, but also upon the pieces (belonging to both players) that remain on the board and their relationship. This criterion would factor in the importance of avoiding a Pyrrhic victory as well as introduce a moral mandate to honor the means independently of the goal.[12]

In our subsequent discussion, the valuations of material and positional parameters shall denote internal valuations only.

Valuations of Material Parameters

In theory, we can construct a *continuous* spectrum of valuations in terms of their unconditionality. In practice, we observe certain phases, for shifts in the valuations involve structural changes in the factors that determine their magnitude.

Let us take two extreme cases of the spectrum: completely conditional valuations and completely unconditional ones (or simply conditional and unconditional). Assuming we can formulate the goal (whether final or intermediate) explicitly and devise a program to achieve it, the valuations of all the pieces partaking in this task will be conditional at each step of the procedure. In other words, these valuations reflect the specific contribution made by a given piece in a given position toward achieving the set goal. These conditional valuations could be termed *combinational valuations*. I want to emphasize that combinational valuations *do not apply* to the valuations of the elements comprising the

target state. As far as the ultimate goal of the game, in this case the valuation of the king, the valuations of these elements are defined externally. In the case of an intermediate goal, the valuations of the pieces comprising the target state are *semiconditional,* because their impact upon the future course of the game (i.e., after the set goal is attained), is not fully known.

The other extreme case of combinational valuations are the *unconditional valuations* of material parameters. Here, each piece has no definite value since, in the general case, the valuation of a given piece in some position that might arise in the future is not known. Under these circumstances, the evaluation of a chess position could be based on any valuation of the material parameters, provided they add up to less than the external value of the king.

The notion of unconditional valuation of the pieces is not all that outrageous. For instance, there are cases when the queen, which is recognized as the strongest piece, turns out to be useless (zero valuation) or even harmful. The latter occurs when the presence of a queen results in stalemate or checkmate (if it blocks its own king that is in check) in an otherwise won game.[13]

All these deliberations on the unconditional (or nearly unconditional) valuations of the pieces seem irrelevant and overly abstract, since they apply to only very unusual situations. The relevance of these logical drills will come to the foreground when we examine the spectrum of valuations in systems, which lack a well-defined goal or even a well-defined course of development.

To sum up, extreme valuations are ineffectual in evaluating the material and must be replaced by *semiconditional* valuations. In theory, the latter can be derived statistically or calculated analytically. The respective methods are based either on the averaged *out* information about the system or upon certain relations among the system's components, which were not eliminated during the averaging out process.

This alternative raises a very interesting question: “Why resort to these analytical methods of computing the values of chess pieces when these values can be determined based on the very extensive statistical data?” Perhaps, the established values of the pieces used in assessing a chess position do represent this kind of averaged out valuations, generated by centuries of chess playing experience. In response to my question—“How is the relative value of the chess material determined?”—a number of grandmasters said that the values are generated intuitively based on experience, the experience of assessing which positions are equal. The established magnitude of these semiconditional valuations are: queen 9, rook 5, bishop 3, knight 3, and pawn 1.

For our purposes, it would be highly intriguing to define an *analytical* procedure to compute the semiconditional valuations of chess material. In chess, such a procedure would have to pass a double test. It would have to be verified experimentally (by incorporating the generated semiconditional valuations into the chess programs) as well as by comparing the found magnitudes with those arrived at empirically. Also, an analytical procedure would reveal certain methodological principles underlying the calculation of semiconditional valuations in other systems, which might not yield to alternative (analytical or statistical) methods of calculation.[14]

This exact analytical procedure for computing the semiconditional valuations of chess pieces was developed by Henry Taylor (1876). Essentially, it employs the following approach: we first fix the position of a black king on an otherwise empty board, then take one white piece at a time and compute the following characteristic: the number of safe checks (the checking piece cannot be captured by the king) that piece can make given the position of the black king. The procedure is repeated for each square of the board (64 times) occupied by the black king and for each white piece (pawn, queen, rook, knight). The next step is to determine the ratios among the sum totals of safe checks given by each piece (divided by the total number of squares occupied by that piece). The discovered ratios were very close to the empirical valuations used in practice.

The analytical procedure outlined above suggests a number of generalizations. First, the procedure only takes into account the *rules of the game*, or *rules of piece interaction*, ignoring the final goal or the possible configurations of the pieces on the board. In fact, Taylor's procedure incorporates only the basic rules, namely how pieces move and interact with the opponent's king (i.e., ability to capture the undefended checking piece if it falls within the king's operating range). Relatively minor rules, such as castling, stalemate, etc. were omitted.

To sum up, Taylor's procedure for calculating the semiconditional valuations of the material takes into account only the rules of piece interaction. It represents a radical departure from the procedure (for computing conditional valuations of the material), which relies on the totality of the goal, an exhaustive description of the positions of all the pieces initially placed on the board, and the rules of piece interaction.

In my previous works on indeterminism and the spectrum of conditionality covered by the valuations (Katsenelinboigen, 1992), I wrote that these semiconditional valuations are unconditional. Actually they are semiconditional: while independent of the specific position on the board or the final goal, they do take into account one very important element, namely the rules of piece interaction.

Taylor's procedure possesses a number of features, which reflect the nature of the chess game. Pieces were combined by juxtaposing one piece at a time with the opponent's key piece—the king—based on the criteria of posing a threat to the king. The use of this criterion to assess the values of the pieces is not a trivial task. No matter which *single-parameter* criterion we pick, it will invariably fail to incorporate all the features of a given piece. For instance, the criterion based on the number of squares accessible to a given piece from a given square in *a single* move fails to account for such an important parameter as the possible trajectories available to that piece.

However, as soon as we combine two or more parameters we face the very difficult task of integrating them. Taylor's criterion, namely the number of *safe checks*, was actually an attempt to synthesize the various parameters reflecting the strength of the piece. One was the aforementioned ability to reach from a given square any other square in a single move and the other was the trajectory of the moves.

The intricacies of Taylor's procedure become apparent once we compare a knight to a bishop—the safe checks criterion integrates several parameters characterizing the strength of a piece.

Jumping back to the spectrum (in terms of degree of unconditionality) of material valuations, our subsequent analysis is limited to the part of the spectrum between semiconditional valuations and completely conditional valuations. This segment features its own valuations which I have termed *partially conditional*. It differs from the conditional valuations typical of the well-defined narrow goals set in a similarly clear-cut environment. This part of the spectrum also possesses features which distinguish it from the semiconditional valuations, the main distinction being the idea that the partially conditional valuations depend on the structure of the position, but are not linked to any final goal.

Emanuel Lasker (1937) writes that the relative values of the pieces in the opening differ depending on their initial positions (p.111). Moreover, they do not match the commonly accepted weights of the pieces. The second column of Table 2.2 gives the values according to Lasker; other columns compare his values with the commonly accepted ones.

Table 2.2
Values of Pieces in an Opening and Their Established Values

Piece	Value in opening	Averaged out value			Difference between relative averaged out value	
		opening		general	in opening and overall	
		Type of piece	Rel. to pawn		absol.	%
Pawn: *d* or *e*	2.0	1.3	1.0	1.0	0.0	0.0
" *c* or *f*	1.5					
" *b* or *g*	1.25					
" *a* or *h*	0.5					
Knight	4.5	4.5	3.5	3.0	+0.5	+16.7
King bishop	5.0	4.75	3.65	3.0	+0.65	+21.6
Queen bishop	4.5					
King rook	7.0	6.5	5.0	4.5	+0.5	+11.1
Queen rook	6.0					
Queen	11.0	11.0	8.5	9.0	- 0.5	-0.6

It seems the discrepancy between the valuations presented in Table 2.2 and the established semiconditional valuations are due to the various positional parameters that enter into consideration.

For instance, pawns *d* and *e* possess higher values because they are associated with such an positive positional parameter as the control of central squares; knight's higher value is based on the restricted movement (the reciprocal positional parameter is mobility) of all other pieces at the beginning of the game.

There are many other examples of opening and endgame situations when the partially conditional valuation of a piece differs from its semiconditional

valuation, in lieu of certain positional factors which come into play. For example, Tarrash regarded a knight that is placed in the center of the board, and exempt from the attack by the opponents pawns but at the same time defended by one's own pawns, as stronger than the bishop and almost as strong as a rook.

The following statement summarizes our discussion of the spectrum of the valuations: *greater degree of conditionality of the value of the pieces in a given situation represents the pieces' semiconditional valuations being supplemented by the valuations of pertinent positional parameters.* These valuations are useful if only because they alleviate the need to compute these magnitudes every time.

Naturally, the sum total of the pieces' conditional valuations is a virtual number (a convention), certainly not equal to the evaluation of the overall position because many positional parameters apply to a group of pieces.

Positional Valuations of the Pieces

Before we proceed with the methods of integrating the semiconditional valuations of the pieces with the valuations of positional parameters, let me say a few words about the structure and valuations of positional parameters.

There is no known deductive theory to construct positional parameters or their valuations—a task invariably performed by the intuition of chess players.

The set of positional parameters is very diverse; it includes parameters pertaining to pawn structure (double pawns, backward pawn, isolated pawn, pawn chain, etc.); to the relationship between a piece and some part of the board (rook on an open file, bishop on an open diagonal, etc.); to piece interaction (two bishops, bishop and knight, variety of pieces on the board, etc.) and to many other types of structures.

One of most intriguing and difficult issues is to establish relative total value of positional parameters to material (the latter is considered decisive). The first question: What is the material equivalent for the sum total of all the positional parameters? In different chess programs the total value fluctuates from one to three (usually two) pawns. Chess players, on the other hand, sometimes place a greater value on the positional parameters relying upon an intuitive procedure, which has been difficult to formalize.

The second question is how to tabulate the valuations of positional parameters. There is a general agreement as to the ordinalistic ranking of certain positional parameters, which are either self-evident (for instance, double pawns or a backward pawn) or validated by some great player (for instance, Richard Reti (1981) purports that William Steinitz proved the superiority of two bishops over a bishop and a knight). In the general case, positional parameters defy a universally accepted ordinalistic valuation. Cardinalistic ranking of positional parameters is lacking altogether; to a great extent they are all individualized.[15]

The answer hinges on the individual qualities of the players. Unlike semiconditional valuations of the pieces, the valuations of positional parameters are not shared, but are player specific. This does not preclude these valuations from being unconditional in time, that is, being utilized by a given player whenever

the need for semiconditional valuation of positional parameters arises. I shall elaborate upon this point when I discuss the role of subjectivity in chess.

The synthesis of unconditional valuations of the material and positional parameters is multi-faceted, two facets being *explicitness* and *completeness*.

In the above example (piece valuations in the opening) the synthesis of semiconditional valuations of the pieces and the positional parameters was *explicit*. At the same time, it may be *concealed* within the algorithm of search for the solution to a local problem. Moreover, the relation between the valuations of material and positional parameters may be resolved completely or partially.

Assuming each dimension of the valuation structure is binary (explicit-concealed and complete-partial), these two dichotomous criteria generate four possible combinations.

For example, concealed-complete scenario arises over the course of combinational play with respect to every intermediate position.

When piece valuation is based on statistics (i.e. on the history of that piece's performance under various circumstances), the combination of semiconditional valuations of the pieces and positional parameters is also *concealed*, but it is only *partial*. The reason it is not complete is that statistics is oftentimes ill-equipped to incorporate all the pertinent intermediate links between the valuation of the piece and its positional parameters.

In case the semiconditional valuation of the piece and positional parameters is derived *explicitly* the link between these parameters is usually partial, for it is unclear how to devise a complete set of positional parameters and their respective valuations.

Since this fusion of semiconditional valuations of the pieces and positional parameters is, for the most part, *incomplete,* I want to introduce the term *positional valuation of a piece* to signify this kind of synthetic valuation.

As suspect as it is, the positional valuation of a piece might come in handy in plotting a combination. Successful combinations hinge upon at least two factors: goal selection (the piece targeted for capture;) and means selection, (a program to execute the set goal). Presumably, positional valuations of the pieces could help systematize the process of target selection. The piece most susceptible to a combination is one showing inferior positional valuation—this piece might be intrinsically weaker than the other pieces plus relatively undefended (more on this below when I discuss the chess algorithm proposed by Botvinnik, which is predicated upon a combinational approach).

Our discussion of the spectrum of unconditionality of piece valuations yields a number of generalizations. Valuation of a piece in a given position is really an amalgam of its unconditional valuation, qualified by its mobility and relevant positional parameters. Whether this fusion is explicit or implicit, complete or incomplete, is irrelevant in the present context. If there was an optimization algorithm to play chess (which is an extreme case), it would implicitly generate *combinational valuations*, that is, conditional valuations reflecting the weight of that piece in a given position in terms of the final outcome of the game. The other extreme case is when the valuation of a piece is purely unconditional (undifferentiated). Here, to augment the conditionality of the valuations, the po-

sitional valuations are supplemented (explicitly of implicitly) with the piece's mobility factors and other relevant positional parameters.

The two facets of constructing the spectrum of unconditional valuations of the pieces can be enhanced by another variable, namely the homogeneity of the methods employed in constructing this spectrum. Under a simple binary scheme, these methods fall into two categories: *homogeneous* and *heterogeneous*. A homogeneous method denotes a procedure based on a *single method*, for example the method of induction (the law is induced based on previous experience). A heterogeneous approach entails a *combination of different methods*. For example, semiconditional material (piece) valuations can be derived deductively (Taylor, 1876) based on the number of safe checks that each piece acting alone can give to the opponent's king.

To sum up, the material valuations comprise a spectrum that ranges over various degrees of conditionality. Designation of four *phases* within this spectrum is useful both methodologically and pragmatically. By identifying combinational, positional, and semiconditional material valuations, we recognize the primacy of unconditional valuations in supporting the holistic conceptual vision of the problem.

Chess players, on the other hand, tend to reduce piece valuations to two categories. Botvinnik (1987) writes: "the game of chess represents a generalized form of exchange of material and circumstantial weights of the pieces... Circumstantial weight denotes the true strength of the piece as measured at a given moment of the chess battle; the material weight is the established average strength of the piece" (p. 241).

It seems to me that reducing material valuations to two categories—circumstantial weight and material weight—is an oversimplification. The *material* weight parallels the semiconditional valuation of the material. But *circumstantial weight* embodies both the combinational as well as positional valuations of the pieces, a crucial distinction for developing an effective chess algorithm.

COMBINATIONAL METHOD (STYLE)

Definition of a Combination

The combinational method features a clearly formulated limited objective, namely the capture of material (the main constituent element of a chess position). The objective is implemented via a well-defined and usually unique sequence of moves aimed at reaching the set goal. As a rule, this sequence leaves no options for the opponent. Finding a combinational objective allows the player to focus all his energies on efficient execution, that is, the player's analysis may be limited to the pieces directly partaking in the combination. This approach is the crux of the combination and the combinational style of play.[16]

The notion of a combination may also incorporate an element of surprise and sacrifice. This perspective informs the definition given in a wonderful book *Chess Player's Dictionary* (1929). Botvinnik (1987) espouses similar views: "A combination represents a forced variation involving a sacrifice" (p. 67). He

distinguishes between a combination and a forced maneuver, classifying the latter as a "forced variation involving no sacrifices."

There is no unanimity as to the proper definition of a combination. Emanuel Lasker (1937) defines it as a series of forceful moves, that is, moves that invoke a major shift in all values (for instance, a checkmate, capture of a piece, and the promotion of a pawn).

> Such violent moves are opposed by moves equally violent. Attack and counter-attack form a continuous chain. If the links are joined in a simple sequence, the chain is called a "variation." It is frequently the case that the chain branches out at nodes where two or more threats or replies are possible. Here, we use the plural "variations," or a "maze" of variations.
>
> ...In the rare instance when the player can detect a variation or a "maze" of variations which achieves the set goal by force, the totality of these variations and their logical structure are named a "combination." (pp. 109-110)

Peter Romanovskii (1990) proposed the following definition: "A combination is a variation (or a series of variations) where each side makes forced moves and which leads to an objective advantage for the active side."[17]

I favor the definitions given by Lasker and Romanovskii over the one proposed by Michail Botvinnik.[18] It suffices for a combination to set a well-defined narrow goal which results in drastic reevaluation of the position and to devise a program of execution. Sacrifice represents a species of a combination (by analogy, a *positional* sacrifice represents a "variation" on the positional style).

The Chess Computer Program Based on Combinational Style

Definitions of a combination come in handy in formalizing the game and developing advanced chess programs. This brings us to the structure of the computer algorithm designed by Michail Botvinnik and his colleagues (1968, 1979, and 1984). I shall skip the specifics, which an interested reader can easily find in the books. My purpose is to critically examine Botvinnik's basic scheme.

His approach is predicated on the typical combination-driven attempt to set up a position which will radically alter the situation on the board, i.e. lead to a cardinal reevaluation of the current values of all the pieces.

There is plenty of literature on how to set-up a combination. The first issue is picking the target and respective recommendations encapsulate certain concepts designed to enrich players' intuition. In Emanuel Lasker's book (1947), the chapter on combinations focuses on distilling the basic idea underlying a combination. The idea is discovered by finding a combinational *motif*, that is, selecting the target piece. These motifs are based on piece mobility (or lack of mobility) or piece configuration (say, an unprotected queen and king on the same diagonal). Motifs are many and diverse and they coalesce in peculiar ways. Lasker contends that finding the motif is preceded by pinpointing the *function* of a

piece (for instance, protection of another piece) and determining whether that function is fulfilled effectively. Having fixed the function and the motif the player proceeds to assemble the move sequence to attain the set goal.

So, the primary ingredient in setting-up a combination is the formulation of a goal, that is, targeting a piece which is positionally inferior. The next step is to work out a program to implement the set goal.

These techniques are helpful in formalizing the process of setting-up a combination. Botvinnik's great achievement (apart from becoming the world champion) was his attempt to formalize this task.

His approach introduced a modified weight function. It involved finding the *goal* represented by one decisive variable, namely capturing the opponent's material. The target is picked by comparing the aforementioned circumstantial weights of the pieces (to use Botvinnik's terminology). Here is an excerpt from Botvinnik's book (1987):

> In 1968 in my book *Algorithm of Play in Chess* I wrote: in my opinion, the game of chess (and probably any other game) is based on a generalized exchange, meaning an exchange which involves (in the general case) both material and positional (invisible, circumstantial) weights. Unlike the material weights which reflects the average strength of a piece, circumstantial weights reflects its real strength in a given position. The question is to how to compute and formalize these circumstantial weights?
>
> In developing a subprogram to govern the exchange of material weights of the pieces at some square of the board (1978) we took into account the possibility that the piece in question may be exchanged at more than one square. We decided to assign a "spot" (mark) based on each exchange; we dubbed our procedure the "lady bug method". By analogy, this procedure was applied in computing the circumstantial weights.
>
> Previously, the trajectory of a piece was assigned material priority based on the exchange of material weights (actually, setting priorities distorted the results). We decided to use priority ranking to define the size of the spot of the piece connected to a given trajectory (based on exchange at a square). As a result, the piece acquires spots which vary in size. The circumstantial weights of the piece is calculated based on these spots. Material prioritizing was replaced by circumstantial prioritizing and the Pioneer's search algorithm now resembled that of a chess master. (pp. 246-247)

The crux of the proposed algorithm is to define the most effective trajectories for the pieces partaking in the attainment of the set goal. Botvinnik did acknowledge that in the extreme case when the program cannot find ways to gain material it may resort to the general form of the weight function to evaluate the position.

The passage below sheds some light on Botvinnik's philosophy of chess as manifest in the Pioneer chess program:

> Over the last 25 years I worked on the problem of an "artificial chess master." I have come to the conclusion that the key component of such an algorithm is positional analysis incorporated into the weight function. This function allows the master to select high priority moves to be included in the search, to determine when to terminate the search, and to evaluate positions at the end of the search—in other words to select a move.
>
> I believe grandmaster approach is based on three factors:
>
> 1. The balance of material available to each player (Δm). This is the most prominent factor and it serves as the starting point as the beginners embark on their voyage of positional understanding (rather primitive at first).
>
> 2. Expectation of material gains (mg*). Here m denotes material, g - the goal, and * - the guiding light. mg* is the material, the weight of the piece targeted by the opponents pieces. However, this variable signifies not just material under attack, but material subject to a mounting attack. So, mg* is the material expected to be captured.
>
> 3. Purely positional factor (p): control over certain squares of the board and traversability of the trajectories leading to an attack of the opponents pieces. (p. 255)

Botvinnik (1987) qualifies the second factor: "Combinational play, a sacrifice so much appreciated by chess fans, is based on the second factor (mg*); a combination always involves a sacrifice which is more than offset in the end. Emergence of mg* is a precursor of a combination. Material (m) can be sacrificed if it less than the material gained as a result of the combination" (p.255).

The scheme proposed by Botvinnik represents an enhanced version of Shannon's weight function. Botvinnik supplements material and positional parameters with a new group of variables called mg*—material one expects to win. However, the two approaches spotlight very different features of a position. Botvinnik considers the general structural features of the position in order to analyze it and, more important, to contrive a combination. These components are not additive. Shannon's approach examines a position based on the additive properties of its components in order to determine the best possible outcome.

From the late 1960s to his death in 1995, Botvinnik tried to develop a formalized algorithm of combinational play. This work remains unfinished, which in no way diminishes Botvinnik's contribution to computer chess. His ideas on searching for a material target as the basis of a chess algorithm are intriguing. While no successful algorithm was created, a number of interesting ideas (some having general mathematical significance) emerged from Botvinnik's work. Boris Stilman, a long-time associate of Botvinnik, uncovered new ways to

formulate the proposed techniques mathematically. The new avenues of research were rooted in mathematical logic and theory of formal languages. Stilman (1995) termed this new branch of mathematics *Surface Linguistic Geometry*.

However, it appears that Botvinnik's heavy reliance on the ideas of combinational play and his attempt to reduce the chess algorithm to combinational style (except for the openings) precipitated certain conceptual problems that prevented him from developing a competitive chess program. Perhaps one reason for Botvinnik's failure to develop such an algorithm was his neglect for the overall positional valuation, which embodies positional parameters pertaining to the position as a whole rather than to the individual pieces. One example of such positional parameter is the *quantity* and *variety* of pieces that are still in play. Former world champion Michail Tal' nurtured this particular parameter in assessing a position. His style aimed at creating highly entangled positions that are hard to resolve during the limited time allotted for the game. Large quantity and diversity of pieces is certainly a prerequisite for creating such muddled positions. Another argument supporting the overall valuation of a position hinges on the idea that material superiority may prove insufficient if the drastic change and material advantage fail to compensate for the ensuing positional disadvantages.

Perhaps, the main reason for Botvinnik's lack of success was his infatuation with one single method rather than a strategy based on the synthesis of diverse methods of play. If so, it is all the more important not to discard Botvinnik's results in developing an algorithm based primarily on combinational style, but to integrate it with other methods.

The Ideological Origins

To conclude my brief excursion into Botvinnik's approach, I believe that in general, the author's mindset exerts a strong influence upon the methods he proposes. Of course, we need to qualify the statement, for the long chain linking the author's mental attitudes and his scholarly output is mediated by numerous intermediate steps. However, one key intermediate stage is the development of *heuristic principles,* which is particularly crucial in developing innovative solutions. Perhaps, the vehicle that allowed Pierre Maupertuis to lay the foundation for the variational principle of *least action* in mechanics was his deep faith in God and the ensuing profound aspiration to search for the principle upon which God created a perfect world of planetary motions. In the same vein, the groundwork for optimal planning utilizing techniques of linear programming was laid by Soviet mathematician Leonid Kantorovich, who was a firm believer in the superiority of the plan-based system over market-type system. Kantorovich also endeavored to improve the existing economic system of planning by manipulating the material parameters and their valuations.

Like Kantorovich, Botvinnik believed in the rational methods of control and thought planning superior to market. It is quite possible that Botvinnik per-

ceived the economic mechanism as a mechanism aimed at achieving a material advantage, with all available resources subordinated to that goal. The notion of creating predisposition toward development and evaluating predispositions as means not directly contingent upon the goal was probably foreign to Botvinnik's cognitive social thoughts.

Whatever the case may be, my speculations regarding Botvinnik's philosophical outlook are in line with his article entitled "Intelligent Economic Computer or How the Poor Need Not Be Poor." It was published by *Pravda* on October 18, 1992. The fact that this conservative newspaper published the article in fall 1992 with an editorial statement introducing the author as a long-standing contributor to *Pravda* is highly suggestive. At around the same time *Pravda* featured a collective article addressed to Boris Yeltsin with an appeal for him to resign from his post (Yeltsin was then allied withYegor Gaidar in promoting the transition to a market economy).

Personalities aside, let us look at what Botvinnik's article has to say. The main point is that his algorithm will help create a vigorous economy geared toward higher output. The producers (producer chains) need only seek to maximize their profit, that is, strive for material advantage. The article makes no allusions to improving the firm's economic position, which, along with profit (material parameter), incorporates a host of positional parameters (market share, assortment of product lines, etc.). Botvinnik emphatically reiterates that the relation between the type of property ownership and the system has no impact on obtaining optimal results.

Rather than reject the idea, I prefer to define the conditions under which the idea is correct. Botvinnik's idea does work under certain conditions. The only stumbling block is the utility of this model in analyzing the economy in the dynamic environment of the real world subject to research and development (R & D) innovations. The limitations of Botvinnik's assumptions are manifest in the failure of his scheme to fully incorporate the multistage process of "production and implementation" of innovation driven by R & D, particularly those stages of R & D which do not yield (or hardly yield) to expert evaluation, this is where the social relations and the property rights come to the fore.

In the following chapters devoted to predispositions in economic systems I shall elaborate on the set of conditions under which the system of optimal planning akin to the one proposed by Botvinnik is adequate. Let me just add that I understand the temptations beguiling Botvinnik. In the 1960s, when I was working at an institute that was part of the Soviet Academy of Sciences, my colleagues and I were lured by the prospect of constructing such a deterministic system of optimal economic performance (Katsenelinboigen, Ovsienko, Faerman, 1966). Rather than using chess as a guide, our approach was based on the decomposition methods of mathematical programming. It was by analogy with chess and the notion of enhancing one's position, that I came to recognize the significance of indeterministic economic thinking (and respective institutions of property, etc.) and the limitations of the deterministic approach to the economy.

VARIETY OF POSITIONAL STYLES

One of the greatest revolutions in chess occurred with the shift from a combinational to a positional style of play. The positional style did not eliminate the combinational—it only limited the scope of its implementation. In chess, thanks to the existence of a closer, the elaboration of a combination can *follow* the creation of a position. In real life it is not so. The infinity of real life always is requiring the creation of a position. A combination is becoming a fragment that is implanted in the development of a position.

Steinitz undertook a systematic development of positional ideas thus making the positional style accessible to other payers. Let me quote Emanuel Lasker (1947):

> The world did not comprehend how much Steinitz had given it; even chess players did not comprehend it. And yet his thought was revolutionary...
>
> ... And it is no wonder that the chess world did not appreciate Steinitz, neither his style of play nor his written word nor did any chess patron, in sympathy with his genius and divining his greatness, ever come forward to his support. Surely, Steinitz's heart skipped a beat when it first dawned on him that the master should not look for winning combinations, unless he firmly believed that he held an advantage. That meant making no attempt at winning in the beginning of the game. And since Steinitz lived in a milieu in which to play to win right from the start was considered the only honorable course, his thoughts must have received a timid reception in his mind and a hard time establishing itself. (pp. 189-197)

Positional approach has come a long way since Steinitz's time, branching out into many substyles. As far as the *scope of analysis of the game* (or a long stretch of the game), positional style has two subvarieties. The first entails a *step-by-step improvement of one's position*; the second is *comprehensive*. The latter is called *strategic positional play* because it is predicated upon developing a game plan.

In terms of the degree of change, I distinguish between *incrementalism* and *radicalism*. Incrementalism entails piecemeal steps and in case it is supplemented at each step by isolated improvements of some part of the position, it is termed *disjointed incrementalism*.

Each of these categories of the positional style can be further broken down based on the following criterion: is the method used to rank the positions by *probabilities* based on observe *frequencies* or is it based on the valuation of a *structurally represented* (meaning both *material and positional parameters* are represented) position or its various constituent parts.

Figure 2.2 shows the possible combinations of these variables defining positional play.

Let us begin with the positional style which is rooted in probabilities based on statistically observed frequencies. In the simplest case, the decision boils down to selecting (from the many games played in the past) the move with the

highest probability of winning in a given position. This is a degenerate case, in the sense that the only decision-making information required is the material and its coordinates—the relation among the pieces is irrelevant.

But what happens when the position is new (unique), that is, there is no statistics pointing to the most promising continuation?

To the best of my knowledge, this problem was tackled in the 50s by the well-known scholar Herbert Simon. He attempted to reduce a new position to a known similar position by dissecting the new and the old positions into common chunks. Because the notion of similar is extremely fuzzy, this procedure was doomed to fail. An attempt to revive Herbert Simon's approach to analyzing a unique position has recently been made by the Deep Blue team preparing for the 1997 match with Gary Kasparov. In his article (1997) on the 1997 rematch Bruce Weber writes:

> There was an aborted attempt to adapt a program called Flash, which detects similarities in genetic patterns among humans and other creatures, to chess. The idea was that if the computer could recognize a situation on a chessboard that recalled a game previously played by a grand master, perhaps it would be able to apply the grand master's logic. It did not work. A chess game has so many variations and nuances—a difference on a single square can mean uncountably different possibilities—that defining similarity turned out to be too daunting. (p. C 32)

Figure 2.2
Scope, Degree of Radicalism, and Valuation of a Position

Scope	Degree of radicalism of change	Selection based on:	
		Evaluation of the overall position	Probabilities based on observed frequencies
Step-like	Incremental		
	Radical		
Comprehensive	Incremental		
	Radical		

Consequently, the process of move selection in a unique position must resort to the weight function, which could incorporate chunks (of varying complexity—a single piece is an extrem simplest case) as independent variables (analogous to material parameters) and their respective valuations as well as such set of independent variables as relations between the chunks and their respective valuations.

The blueprint for a chess program based on a *step-by-step improvement* of one's position combined with the valuation of the overall position is encapsulated in the aforementioned weight function elaborated by Claude Shannon.

The most trivial approach toward this step-wise refinement is to *broaden* the search (i.e., generate all possible positions and then select the best one). The so-called *brute force* search presumes maximum breadth, meaning the generation of all possible positions. This kind of search assures that all positions are analyzed and no promising variation is omitted.

The fact that the set of positional parameters incorporated into the weight function is incomplete and, more importantly, the fact that these parameters are assigned semiconditional valuations makes it impossible for the evaluation of a position at each move to ensure both local and global optimum. As a result, every effort is made to extend the algorithm's search depth (number of plies a program searches).

Time and speed constraints make for a trade-off between breadth of search and depth of search. To maintain the breadth of search, the program designers seek to increase speed by introducing specialised parallel chips. This trend is very typical of the Deep Blue program. In grooming the machine for the 1997's rematch with Kasparov, the computer's speed was doubled increasing its search capacity from 100 million to 200 million positions per second with 512 processors working in parallel.

Another way to preserve the algorithm's search breadth is to improve on the structure of the weight function, which would ensure the effectiveness of the search with a fixed search depth. This technique was also used in the process of preparation for the 1997's Deep Blue match with Kasparov. Quoting Bruce Weber's article (1997):

> The heart of the mystery lies, apparently, in Mr. Benjamin's earlier contributions. In examining situation after situation, he was trying to determine the occasions during which the computer's sense of a chess position was incomplete or unsophisticated.
>
> "For example," Mr. Benjamin said, "I noticed that whenever Deep Blue had a pawn exchange that could open a file for a rook, it would always make the exchange earlier than was strategically correct. Deep Blue had to understand that the rook was already well placed, and that it didn't have to make the exchange right away. It should award evaluation points for the rook being there even before the file is opened.
>
> This gets at Mr. Kasparov's frustration. The so called mystery is the computer's ability, at least at some points, to play what is called positional chess, a concept that is difficult to define." (p. C 32)

But all of these improvements of a brute force method are not sufficient to reach such a position that can assure the optimal continuation of the game; even such advanced specialized program as Deep Blue, using the broadest search, was able to look something like four moves ahead while at least eight moves are necessary for a very efficient continuation of the game.

Since search depth is so crucial,[19] efforts in chess programming have focused on limiting the number of variables in the weight function and especially by narrowing down the search tree (chopping off from the search tree those branches which hold no or little promise of deserving moves). These methods are flawed, for there exists no definitive criterion for eliminating irrelevant positional parameters or unpromising moves from the search procedure. The result is that most chess programs sought to preserve as many positional parameters as possible and to support maximum breadth of search.

A completely different approach to a step-wise analysis of a position was proposed by Hans Berliner (1989) for his Hitech chess algorithm. I would dub Berliner's method *decompositional*.[20] The basis of his algorithm is the following: each piece generates the best move from the set of legal moves according to the requirements of the center-mediator. The center receives this information from every piece and then reinspects its analysis and comes up with new demands for the kind of information it needs. This procedure must ultimately converge to reflect the goal of the game.

Our discussion of the step-like incremental positional play raises an interesting question: Is it possible to devise an effective (ultimately an optimal) course of action based on the valuation of the current position? The question really concerns the plausibility of constructing a weight function to evaluate any intermediate chess position which would satisfy the *optimal strategy* subject to the following constraints: (a) final goal is well-defined; (b) number of material parameters and the rules of their interaction is fixed; (c) material parameters are evaluated semiconditionally; (d) valuation of positional parameters is based on past experience.

The question can be reformulated to ascertain the mere *existence* of such a weight function.

Whether or not such a function exists, the following issues need to be resolved in order to address the following: (1) selecting appropriate valuations for the chess material (semiconditional, positional, combinational) and defining the respective domain of these valuations; (2) constructing the set of positional parameters to be incorporated into the weight function; (3) elaborating ways to represent positional parameters; in the simplest case, one could use averaged out valuations for each individual parameter derived from past experience; (4) examining the possibility of representing the weight function as a linear polynomial, that is, will a linear polynomial series yield an optimal move (we must take into account the fact that material parameters are integers and positional parameters are strongly interdependent).

Putting the question more concisely: is it possible for the valuation of a position by means of a nonlinear weight function, which incorporates the material, the terrain (relation between the material and the squares), and positional parameters, to generate an optimal solution?

To the best of my knowledge, there is no proof of *existence* of a min-max chess algorithm, which ensures than any given move is optimal in terms of the global criterion. The great David Bronstein, regarded as unsurpassed in the art

of judging irrational positions (positions in which "the material is so uneven, one wonders how the player can go on" notes:

> In some positions, it is next to impossible to find the features (perhaps, figments of imagination) which would allow one to collate the pros and cons of a given position.... Either chess theory has failed to find all the features which would exhaust all the intricasies of chess, or, perhaps, there are "out of balance" positions which preclude the application of these features.[21]

Let us look at another cell in Figure 2.2. This cell combines comprehensive positional play with position evaluated as a whole and via its parts with radical change in the valuation of the position. This is a typical strategic positional play.

Key to strategic positional play is some global *action,* such as an attack against the opponent's king or building up a position ripe for such an attack. This action governs a plan, which incorporates *intermediate tasks* and respective *goals*. These goals define certain positional features, which are composed to a varying degree. For instance, the goal may be to push the opponent's king to some sector of the board, or to re deploy a piece to some square (area) from which it controls the center.

In effect, the formulation of intermediate tasks defines *tactical* aims with goals represented by *dominant* positional parameters. Note that semiconditional positional valuations incorporated into the positional style (in the general case) are here replaced by positional valuations of elementary as well as complex chunks (say, building a strong left flank). Due to this versatility, the strategic positional play merges strategy and tactics. The reverse is not true, meaning a good strategy can be corrupted by poor tactics but poor strategy cannot be salvaged with good tactics.

This fusion of strategy and tactics in positional play is fraught with many pitfalls. One common trap is to overestimate the value of future gains to the excessive detriment of the proximate states. Also, excellent strategic ideas can be easily ruined by the player's inadequate tactical skills resulting in poor execution.[22] Perhaps, the key reason for inapt fusion of strategy and tactics (in setting a tactical goal) is excessive focus on the dominant positional parameter while other positional parameters which define the position are ignored or slighted.

In my opinion, strategic positional style is best portrayed by the scheme elaborated by an outstanding grandmaster David Bronstein (1981). He analyzed chess as a strategic plan broken down into intermediate goals or complex *chunks*. This approach is very different from the traditional *structure-based* segmentation of the game into opening, middlegame, and endgame (the stages are characterized primarily by the number of pieces and their mobility). Bronstein's design is *functional* as each stage is characterized by its respective function (intermediate goal), namely:

1. Creation of a shelter for the king; it is neither a castle nor is it a pill box, since "a king does not fire any shells from this fortress"

2. Formation of pawn chains—the skeleton of the position

3. "Deployment" of the pieces—one's mobile resources—according to their "personalities" and the player's intentions

4. Crossing the "equator" for the purpose of invading enemy territory and destroying or undermining his position

5. "Active defense" (i.e. the opponent's attacks impairs his position so much that "he is forced to admit his defeat after the smoke has cleared")

6. Attack the enemy king—this involves breaking through the pawn chains, capturing space, attacking weak pawns and advancing one's own pawns supported by the pieces

Bronstein proposed certain techniques to help fulfill these functions. For instance, "creation of a shelter for the king" involves more than just placing the king near the edge of the board (as we know, at the start of the game the king is in the center). Bronstein recommends not just building a "shelter, but a castle fortified with a double wall of pawns. A king should be provided with personal bodyguards—a knight, a bishop, a rook, and four pawns" (p. 17).

Let me turn to the interaction between the various styles of play and the strategic positional style. In a sense, the latter embodies all other styles. When no intermediate goal can be formulated it incorporates step-by-step methods, which can be incremental or radical. Strategic positional style harbors certain advantages of the combinational style, including the formulation of a goal and ways to execute it. In the present context, both styles set goals which represent a modified version of the general form of the weight function.

At the same time, the comprehensive positional style is very different from the combinational style. First, the combinational style modulates the weight function (its general form) by setting a *goal* limited to capturing the opponent's *material*; the positional style can aim at both the material and the positional parameters. Second, under a combinational style the *program* linking the goal with the current position is relatively well-defined. The comprehensive positional style emphasizes a *plan*, which serves as the guiding light in the chain linking a given position, the goal, and the various milestones en route to that goal. The specifics of the plan are worked out during the course of the game. As Bronstein (1981) notes, unlike the combinational style, the comprehensive positional style allows "the creation of long-range plans which do not have to take all the possible variations into account" (p. 176).

A combinational style can be viewed as a particular case of the positional style, meaning the goal is expressed via material parameters and the program linking the goal with the initial conditions is detailed and condensed.[23]

Figure 2.3
A Position,Target State Predefined, and the Course of the Game

Degree of change	Target state predefined	Development aims at		
		Specific action	Material gain	Any improvement

Drastic	Yes	Positional plan	Combination	
	No	Positional sacrifice		
Moderate	Yes	Intermediate states of a positional plan		
	No			Step-by-step improvement

Figure 2.3 examines the various combinations between the selective modes of play and complete/incomplete structural valuations of a position.

As potent as it is, the major weakness of the comprehensive positional style is its vulnerability (i.e., its execution may be jeopardized by the counter-measures taken by the opponent).

Step-by-step positional style is also lacking—it entails an exhaustive search due mainly to the fact that the valuation of a position at any given move does not guarantee an optimal global solution. As a result, the algorithm's depth of search is extended as much as possible, but due to the technical limitations of even the most advanced computers (with parallel high-speed processors, customized architecture, etc.) their depth of search is limited compared to the grandmaster's vision. For instance, the computer which runs Deep Blue has 512 specialized processors. It examines an average of 200 million (2.10^8) positions per second. Assuming that four moves generate about 10^{12} different positions (each move consists of two half-moves with 10^3 possible positions) an exhaustive search would take about an hour and half. The so-called *alpha-beta algorithm* essentially reduces this time by truncating repetitive variations. Thus, the step-by-step positional style, even if enhanced by the truncation of undeserving variations, has difficulties to compet with the the strategic positional method used by chess masters.

As powerful as it is, the combinational style is difficult to implement in practice. Prevalent in the nineteenth century, combinational style of play has been hampered by major strides in the art of defense. Chess players have evolved defensive techniques, which have paralyzed the most sophisticated combinational schemes concocted by the opponents. It took the genius of Paul Morphy (1985) and William Steinitz (1889) to resolve this situation by founding the positional style. Interestingly, the history of chess has shown that the positional style has not invalidated the combinational style, but merely enhanced it. But sometimes by the positional style one can enormously simplify the elaboration of a combination. To my best knowledge, the famous grandmaster David Bronstein mentioned that the game between Kizeritsky and Anderssen—that is recognized as the immortal, most famous combinational game—is to a great extent a trivium if it is analyzed from the point of view of the present state of positional play.

Thus, each style and their respective varieties have pros and cons. It seems that the most promising avenue of development of computer chess engenders

the synthesis of the various styles discussed above. Perhaps, the initial version of such a synthetic program would fuse reactive method (particularly in the openings), optimization techniques (especially, in the endgame), and positional style based on strategic planning.[24] We can then complement this amalgam with the combinational techniques, which can be viewed as a particular case of the positional style. If no combination can be defined and no intermediate positional goals are apparent, the program may employ the incremental step-by-step positional method. The latter refines the position making it ripe for a more concrete plan or even a combination. This is where positional parameters come to the fore, that is, a position where no material gain is achievable and the target becomes the accumulation of minor positional advantages.

I am not familiar with any attempts to implement this synthetic approach to chess programming. While top-level players are highly skilled at fusing the various styles of play, no methods to formalize strategic planning or combinational play (not to speak of the interplay between the two) have been elaborated.

Computer chess programs need not imitate the human thought processes. The computer's number crunching capacity may well spearhead a new approach that is foreign to human players (if only because we suffer from limitations rooted in the nature of human beings). Nonetheless, even if the new algorithm proves successful, such issues as space and time will continue to inform the problem of integrating the various styles of play.

CHESS AND CHESS PLAYERS

Individuality and Subjectivity in Assessing a Position

Valuation of a position raises some complex issues related to the implementation of the respective plan based on uniform objective methods. My principal thesis regarding positional valuations is the following: while the set of material parameters and their valuations (particularly semiconditional ones) can be *unified* and *objectivized*, the set of positional parameters and their valuations is basically *individualized* and *subjective*.

Prior to embarking upon the argument corroborating this statement, the reader might want to go back to the last chapter, which elucidates my concept of individuality versus uniformity and subjectivity versus objectivity.

The above terms apply to the *players* as well as the *spectators* observing the game. Say a player comes up with a brilliant combination. The opponent's perception (reaction) during the game may solicit a no less brilliant response (naturally, a full-proof combination will lead to the same result no matter what the opponent's retort is). Now, perception of a combination played in the past is a different story. For instance, *creating* a combination may require great talent while its subsequent *perception* is within the grasp of any advanced player (naturally, creative interpretation of a combination will vary). Positional play presents a much more complex picture. Creation of a position and positional counterplay demands considerable talent on the part of the players; but oftentimes comprehending a positional-style game is also highly demanding. The rea-

son for this is two-fold: the observer has his own stylistic biases and he must penetrate the intricate thought processes of both players who also have their own individual styles—thought patterns which may, in fact, not be apparent to either of them *beforehand*. Consequently, unlike a combination, the many paths available during the course of positional play will usually lead to different results.

This brings up the issue of *elitism* and *egalitarianism* in chess and the role of one's innate abilities.

Playing as well as understanding the game (particularly positional play) does require both talent and toil. There is a distinct elite comprised of masters and grandmasters. Other conditions being equal, the better the players, the greater the role of one's natural aptitude for chess. Even attaining the level of a master calls for certain innate gifts which, if lacking, cannot be compensated by any amount of studying. Not surprisingly there are only about 450 grandmasters in the world. The emergence of the chess elite in no way precludes *egalitarianism* in chess. Millions of people enjoy playing and looking at the comprehensible games played by better players.

Chess is a peculiar blend of egalitarianism and elitism. The game features its own elite, but it was never stipulated that the art created by the elite, especially the art of building up to a combination or the art of a positional sacrifice, be within the grasp of the chess-playing masses. At the same time, this elite caste is very open—membership by birth would be ridiculous. Also, a lot is being done to attract millions of people from all the strata of society to chess, including tournaments and books geared toward players of all levels.

One final note. The distinction between *individualization* and *uniformity* is crucial in resolving constructively the problem of separation between the player and his evaluation of the position. Individualized evaluation makes it impossible to dissociate the one conducting the evaluation from the one who has to act on it. In other words, the individualized evaluation hinges upon the player's ability to carry out the plan based on his evaluation. A grandmaster assessing a position in his own unique way must take into account his ability to follow his assessment through. On the other hand, uniform methods of positional evaluation presume that the operator making the evaluation is irrelevant, for the result can be reproduced by anybody (equipped to do so).

When we deal with *subjectivity*, the player's method of assessing a position is unknown and so cannot be repeated by other players. Perhaps, the subjectivity with respect to positional parameters stems from the player's inability to render precise his own process of creation of these parameters.

Objectivity presumes that the well-defined positional evaluation can be similarly employed (other conditions being equal, with the same results) by any player who has mastered the requisite techniques.

In fact, heuristic methods of assessing a position, the very same methods that are hard-wired into the chess programs, serve as an example of such completely objectivized (formalized) individualized methods. The greatest weakness of the chess programs is that they are fixed, meaning they lack a second-level program to change the algorithm of play. The fact that these programs are im-

mutable makes it easier for their human opponents to detect and exploit their weaknesses (as was amply demonstrated by Kasparov in his 1996 match with Deep Blue).

Time will come when an imperfect program will turn out to be superior to any living player as it has been demonstarted in the 1997 match between Gary Kasparov and Deep Blue (Newborn, 1997). However, as long as the program is incomplete,—that is, as long as it lacks an optimization algorithm or an effective multi-level program, which makes lower level programs amenable to change (at least second and third level programs)—the human genius, which in effect possesses such a hierarchical program, will try to elaborate new ways to exploit the machine's weaknesses and achieve victory.

This brief digression into individuality versus uniformity and subjectivity versus objectivity leads us to elaborate on the weight function as it pertains to positional valuation. Note that the material variables of the function can be made uniform and made objective with respect to both initial and dual parameters. Making theinitial properties of the material parameters objective is a trivial task: the pieces and legal operations with the pieces are unambiguously defined by the rules of the game. Objectivization of the dual characteristics of material parameters is more complex. Using the rules of the game, Henry Taylor (1876) constructed a completely formalized and uniform procedure, which generates semiconditional valuations of the material.

As far as the set of positional parameters is concerned, it is not only individualized but also subjective in terms of both initial and dual parameters.

The choice of positional parameters and the creation of new ones reflects one's personal style of play. For instance, one's style might be geared toward attack or defense; it might aim to challenge the opponent with a very complex plan or to confuse him in the brief span of time allotted to each game (perhaps, in the relative calm of home analysis, the opponent could come up with effective counterplay). The style of play also depends on the one's ability to calculate variations, to keep composure under time pressure, and so on and so forth. The diversity of playing styles comes to the fore in positional play, if only because the future course of the game is unknown and the player must take into account his individual abilities.[25]

Subjectivity, which figures prominently in one's choice of positional parameters, stems from the fact that the respective procedure is largely unknown. There exists no complete (particularly no deductive) program to devise positional parameters and one key factor, which determines one's strength as a chess player, is the individual's creative abilities and the method used to construct the set of positional parameters.

The above considerations apply equally well to the weights assigned to positional parameters. However, it is quite possible for a player (provided he is reasonably strong) to make explicit the *semiconditional* valuations of positional parameters which he employs.

Semiconditional nature of the valuations does not imply that the given player *always* employs these valuations—the valuations depend not only upon one's own style, but also upon the style, preferences, and the valuations es-

poused by one's opponent. In fact, top-level players might even rely on *reflexivity*, that is, they consider the change in the opponent's valuations resulting from his perception of how his opponent (a given player) regards his strengths and weaknesses (Lefebvre, 1977).

Thus, the process of assessing the semicondional valuations of positional parameters must be qualified.

Among top-level players, the subjective perception which enters into their assessment of positional parameters still allows for their assessments to converge, especially in the more common positions. Speaking at the conference on the calculus of predispositions, which I organized in 1992 (more on this in the Introduction to this book), grandmaster Sergey Kudrin suggested that grandmasters generally agree on as much as 90 percent of the cases.[26] Still, the remaining 10 percent on which grandmasters's valuations conflict oftentimes determine the outcome of the game. Kudrin also noted that when he encounters players weaker than himself he has the luxury of being able to ignore the subjectivity in the assessment of a position; using the established valuations is sufficient to outplay the opponents who lack this rudimentary knowledge.

Impact on the Personalities of the Players

It would be interesting to examine the effect of the game on the personality of the players from the following perspective. The idea is to distill the most interesting methodological device found in chess and to consider (through the prism of this device) the general effect of the game upon the personal development of the players as individuals. Of course, we have to assume that all the *ontological* disparities between the chess game and the human conduct still allow for certain invariants between the *methods* of play and the methods which define one's conduct. One such fundamental methodological device found in chess is the idea of forming a position, or creating predisposition toward development. This idea embodies the development of the *object* with which a given subject interacts, as well as the *subject* which also evolves as it interacts with the object.

This idea is nicely illustrated by the following taxonomy proposed by Jamshid Gharajedaghi (1985) and based on the ideas of Russell Ackoff.

This taxonomy gives rise to four classes of relations. Two of them designate to partnership—collaboration and cooperation, and two rivalry—conflict and competition. What makes competition different from a conflict is that the goals of the participants are compatible while the means are incompatible. In the context of chess, the term *goal* stands for a noble goal, such as the enjoyment of the game; the goal of winning merely represents means of achieving this end.

In terms of the above groupings, the game of chess can be viewed as a competition or as conflict.[27]

If reduced to a *conflict*, chess must embrace the intense satisfaction of winning, and fighting spirit, all complimented by some extracurricular activities aimed at disorienting the opponent (but which the opponent may try to ignore).[28] By the same token, this approach to chess is fraught with draining the player as an individual and may even prove detrimental in terms of his playing abilities.

Things are very different if chess is regarded as a *competition* aimed at mutual gratification. I was delighted by Franklin's comments on the potential of chess in shaping the human potential. I shall give in to the temptation to share my enjoyment with the reader by quoting a passage from his book:

> Playing at Chess... is so interesting in itself, as not to need the view of gain to induce engaging in it; and thence it is never played for money. Those, therefore, who have leisure for such diversions, cannot find one that is more innocent; and the following piece, written with a view to correct (among a few young friends) some little improprieties in the practice of it, shews, at be at same time**,** that it may, in its effects on the mind, be not merely inocent, but advantageous, to tile vanquished as well as the victor.
>
> ...That we may therefore be induced more frequently to choose this beneficial amusement, in preference to others which are not attended with the same advantages, every circumstance that may increase the pleasure of it should be regarded: and every action or word that is unfair, disrespectful, or that in any way may give uneasiness, should be avoided, as contrary to the immediate intention of both the parties, which is to pass the time agreeably.
>
> I. Therefore, if it is agreed to play according to the strict rules, then those rules are to be strictly observed by both parties; and should not be insisted upon for one side, while deviated from by the other; for this is not equitable.
>
> II. If it is agreed not to observe the rules exactly, but one party demands indulgencies, he should then be as willing to allow them to the other.
>
> III. No false move should ever be made to extricate yourself out of a difficulty, or to gain an advantage; for there can be no pleasure in playing with a man once detected in such unfair practice.
>
> IV. If your adversary is long in playing, you ought not to hurry him, or express any uneasiness at his delay; not even by looking at your watch, or taking up a book to read: you should not sing, nor whistle, nor make a tapping with your feet on the floor, or with your fingers on the table, nor do any thing that may distract his attention; for all these things displease, and they do not prove your skill in playing, but your craftiness and your rudeness.
>
> V. You ought not to endeavor to amuse and deceive your adversary, by pretending to have made bad moves; and saying you have now lost the game, in order to make him secure and careless, and inattentive to your schemes; for this is fraud and deceit, not skill in the game of Chess.
>
> VI. You must not, when you have gained a victory, use any triumphing or insulting expressions, nor show too much of the pleasure you feel; but endeavor to console your adversary, and make him less dissatisfied with himself by every kind and civil expression that may be

> used with truth; such as, you understand the game better than I, but you are a little inattentive, or you play too fast; or you had the best of the game, but something happened to divert your thoughts, and that turned it in my favor.
>
> VII. If you are a spectator, while others play, observe the most perfect silence; for if you give advice, you offend both the parties; him against whom you give it, because it may cause him to lose the game; him in whose favor you give it, because, though it be good, and he follow it, he loses the pleasure he might have had, if you had permitted him to think till it occurred to himself. Even, after a move, or moves, you must not, by replacing the pieces, show how they might have been placed better; for that displeases, and might occasion disputes or doubts about their true situation.
>
> All talking to the players, lessens or diverts their attention, and is, therefore, unpleasing; nor should you give the least hint to either party by any kind of noise or motion, if you do, you are unworthy to be a spectator.
>
> If you desire to exercise or show your judgment, do it in playing your own game, when you have an opportunity, not in criticizing, or meddling with, or counseling, the play of others.
>
> Lastly, if the game is not to be played rigorously, according to the rules abovementioned, then moderate your desire of victory over your adversary, and be pleased with one over yourself.
>
> Snatch not eagerly at every advantage offered by his unskillfulness or inattention; but point out to him kindly, that by such a move he places or leaves a piece *en prise* unsupported; that by another, he will put his king into a dangerous situation, &c.
>
> By this generous civility (so opposite to the unfairness above forbidden) you may happen indeed to lose the game, but you will win what is better, his esteem, his respect, and his affection; together with the silent approbation and the good-will of the spectators. (pp. 7, 9-11)

Just to reiterate Franklin's point, chess not only promotes the competitive rather than conflict-oriented approach to conflict resolution, but also strengthens the person's aptitude for thinking (the material parameters), as well as being conducive to the development of individual qualities which inform one's conduct, qualities such as cautiousness, perseverance, etc. (the positional parameters).

To conclude this section let me cite a shorter passage from the same book:

> The Game of Chess is not merely an idle amusement. Several very valuable qualities of the mind, useful in the course of human life, are to be acquired and strengthened by it, so as to become habits, ready on all occasions. For life is a kind of Chess, in which we have often points to gain, and competitors or adversaries to contend with, and in which there is a vast variety of good and ill events, that are, in some degree,

the effect of prudence or the want of it. By playing at Chess, then, we may learn,

I. Foresight, which looks a little into futurity, and considers the consequences that may attend an action: for it is continually occurring to the player, "If I move this piece, what will be the advantage or disadvantage of my new situation? What use can my adversary make of it too annoy me? What other moves can I make to support it, and defend myself from his attacks?"

II. Circumspection, which surveys the whole chess-board, or scene of action; the relation of the several pieces, and their situations; the dangers they are repeatedly exposed to; the several possibilities of their aiding each other; the probabilities that the adversary may make this or that move, and attack this or that piece, and what different means can be used to avoid his stroke, or turn its consequences against him.

III. Caution, not to make our moves too hastily. This habit is best acquired by observing strictly the laws of the game; such as, "If you touch a Piece, you must move it somewhere; if you set it down, you must let it in remain."

Therefore, it would be the better way to observe these rules, as the game becomes thereby more the image of human life, and particularly of war; in which, if you have incautiously put yourself into a bad and dangerous position, you cannot obtain your enemy's leave to withdraw your troops, and place them more securely, but you must abide all the consequences of your rashness.

And lastly, we learn by Chess the habit of not being discouraged by present bad appearances in the state of our affairs; the habit of hoping for a favourable chance, and that of persevering in the search of resources. The game is so full of events, there is such a variety of turns in it, the fortune of it is so subject to vicissitudes, and one so frequently, after contemplation, discovers the means of extricating oneself from a supposed insurmountable difficulty, that one is encouraged to continue the contest to the last, in hopes of victory from our skill; or, at least, from the negligence of our adversary. And whoever considers, what in Chess he often sees instances of, that success is apt to produce presumption, and its consequent inattention, by which more is afterwards lost than was gained by the preceding advantage, while misfortunes produce more care and attention, by which the loss may be recovered, will learn not to be too much discouraged by any present successes of his adversary, nor to despair of final good fortune, upon every little check he receives in the pursuit of it. (pp. 7-8)

THE AESTHETICS OF CHESS

Our analysis of the concept of a valuation of a chess position and the subjectivity it entails has lead us to the aesthetic issues in chess. At this point, the

reader may continue reading this chapter or switch to another chapter dealing with the aesthetic method and then come back to my reflections on the aesthetics in chess. The reader familiar with my concept of aesthetics (provided he/she has sufficient empirical material to understand it) may, of course, continue with the present chapter. Otherwise, I would refer the reader to the chapter on aesthetics, which he is now better equipped to understand having read the material on chess.

Let us trace my line of reasoning on the aesthetic method and its key constituent category of beauty as it applies to chess.

According to my definition, beauty is a predisposition toward development.

The structure of both the initial and dual (valuation) parameters of a chess position seems to attest to the static nature of the latter. However, dynamics is intrinsic to these structures, as they are imbued with great predisposition for development. This dynamics is manifest in the underlying valuation parameters which function as forces of attraction/repulsion (attractors/repulsors). Initial parameters also feature hidden dynamics, manifest in the definitions of the pieces in terms of their mobility as well as in the diverse functions fulfilled by positional parameters. Let us take an example: the function embodied by such positional parameter as *connected pawns* is that of mutual aid—an item which is assigned a positive value. The *doubled pawns* parameter reflects the piece's ability (or lack thereof) to maneuver while hindered by obstacles in its path; it also reflects the pawns' lack of mobility. Consequently, this parameter is assigned a negative valuation. The opportunity for a heavy piece (rook or queen) to infiltrate the enemy camp and wreak havoc from the rear is externalized by such positional parameter as *rook occupying an open file*.

The fact that the valuation of positional parameters pertains to the structural features of some constellation of the pieces rather than to specific functions is merely a tool which allows valuations to be assigned directly to the various components which constitute a chess position.

Thus, the category of predispositions encapsulates the dynamics of the entire process, that is, the established parameters and their respective valuations represent in a condensed form the system's predisposition for development.

The evaluation of a given position acts as a springboard for the next step, which is comparison of the evaluations of the positions which arise during the search, and the aesthetic facet of these evaluations. Relative evaluations that are subject to the horizon effect are vital in uncovering the critical points, that is, points which merit in-depth analysis of the resulting branches. For instance, suppose that at some stage of the search procedure the player ends up with a huge material advantage. In order to sidestep the possible trap involving a combinational sacrifice, this particular branch of the search tree may warrant a more thorough analysis. It should be pointed out that the positional style is certainly useful in exposing and stifling the combinations contrived by one's opponent.[29]

My interpretation of positional dynamics suggests an analytical description of the structure of predispositions. I have linked it with subjective valuation which can neither be made uniform nor objectivized. This scheme is missing

one important factor, namely the qualities of the players. A comprehensive analysis of the aesthetic method calls for incorporating the human element, notably the individuals' sensitivity for artistic means and feelings.

Lasker (1947) writes that the spectator can enrich his understanding of chess provided "He has the imagination to follow the drama of the game with interest, and he has intellect to understand what each move aims at and accomplishes" (p. 262). It seems to me this remark applies not only to the spectators (as assumed by Lasker), but the players as well.

In order to create a semblance of a dramatic work, the pieces themselves must be imbued with artistic qualities and thus transformed from mere symbols into actors who represent (perhaps, in a roundabout way) human beings. Similar to theater, these artistic images of chess pieces may be created by dressing people up, as was sometimes the practice in the Middle Ages. In fact, just as in theater, the images could be incarnated by puppets, cartoons, etc. and not necessarily real people. The chess pieces are transformed into images of queens and kings, ships, bishops and knights, infantry (pawns), etc. (Mackett-Beeson, 1968). The version of chess known as Kriegspiel mimicked military combat. Pieces were sculpted as German marshals, colonels, privates, etc. Kaiser appeared in full military regalia at Kriegspiel competitions (Poundstone, 1992).

Mongolian chess is also interesting in this respect: it symbolizes the general concepts of good and evil (Camman, 1946). In keeping with their tradition, the Mongols considered red (as well as yellow) to be a masculine or a spiritual color —the color of the sun; green was seen as a feminine or an earthly color, the color of Earth. The base of the pieces belonging to the two players is colored either all red or all green. (The upper parts of the pieces are painted with both colors, possibly to reduce the stress on the players. It may also signify that each player possesses characteristics associated with both colors.) For a long time, the Mongols considered the Chinese to be their worst enemy. This attitude is reflected in the shapes of the pieces. The facial expressions of the "kings" representing the Mongolian prince and the Chinese ruler are very different. The queens also differ in shape: one is in the form of a lama (a Buddhist lion) and the other is in the form of a tiger-devil (an image borrowed from the primitive prelamaic religion). The shapes of the camels, horses, and carriages are the same for both sides. Pawns are different though. They are carved into shapes of different birds meant to express the conflict between the spiritual and the material, between the heavenly and the earthly.

The pieces must be imbued with human feelings. Let me quote a passage from Lasker's book (1937):

> The vocabulary of the chess pieces is richer than commonly perceived: ambition—in performing the work; fury—if obstructed from doing the work; desperation—for undeservingly suffering a misfortune; rejoice—for getting a lucky break; mockery—of the opponent thwarted by the piece; hatred—for anyone threatening the king, notably "anybody" pinning the piece; cussing—opponent's piece which in any way con-

> straints the piece; laughter—in sidestepping a trap, and even the simple witty expression. (p. 257)

It seems that the rules of chess also posses aesthetic overtones shaped by human feelings, particularly if viewed through the prism of moral tenets. For instance, the rule barring the capture of one own pieces, even under extreme circumstances (such as allowing the king to avoid mate), reflects a moral interdiction against killing someone created in one's own image, even if it means saving your own life. In chapter 4, devoted to the problems of morality, I shall examine in greater depth the connection between aesthetics and morality.

For now, let us consider the aesthetic method as it unfolds during the course of a chess game. The prevailing critical notion states that as a dramatic element, beauty is limited to *peripeteia*—"a sudden change of fortune or reversal of circumstances, as in a drama" (*Webster New World Dictionary*, 1980). For a long time the notion of beauty in chess was though to apply exclusively to the domain of combinations.

Combinations were perceived as entailing peripeteia, frequently associated with a sacrifice which ultimately leads to victory. The delight aroused by a combination corresponds to the *critical points* in the game's dynamics as filtered through our senses. The positional style with its gradual incremental progress by means of accumulation of small advantages appeared as lacking such flamboyant sacrifices and thus somewhat boring.

One well-known Soviet art critic (Volkenstein, 1931), who has pondered the aesthetics of chess, has this to say:

> Beauty in chess springs from the expediency of moves involving peripetia, from the unexpected and seemingly paradoxical resolution of a difficult position. These are the instances when sacrifices take place. Victory achieved through gradual accumulation of tiny advantages without enchanting combinations could be called solid, well-composed, perhaps even instructive and fine, but there is no way it could be called beautiful. (pp. 45-46)

However, let us withhold final judgment on the aesthetic merit of the various styles.

Apart from the novelty of discovering new positional parameters and their valuations, the positional style does, in fact, feature sacrifices, but of positional variety. These sacrifices are oftentimes so unexpected and powerful as to be more daring than a combinational sacrifice. The latter presupposes a preconceived program to make-up for the sacrificed material; in the case of a positional sacrifice the material is forsaken for the sake of improving the positional parameters, that is, the actual compensation for the sacrificed material is by no means apparent.[30]

In summary, let me point out that the evolution of chess has contributed immensely to the field of artificial intelligence by offering various methods

(styles) of analysis of *protracted systems* in which "time is out of joint". This diversity of methods is uniquely integrated in chess.

If we divide the game into three stages (i.e., opening, middlegame, and endgame), and introduce two basics styles, namely selective and reactive, we get 8 (2^3) possible sequences.

For instance, we can start with reactive methods, as is often the case in the opening where pieces are developed according to the established pattern. We then proceed to selective methods in the middlegame, and revert back to reactive methods in the endgame provided it parallels some known endgame positions. Alternatively, in originating a novelty, we can start with selective methods in the opening and then proceed as described above.

I want to reiterate that subjectivity constitutes a major element of one's style (particularly the positional style). Chess styles are not only individualized, but also resist formalization, all of which call forth the player's *intuition*. Advances in chess theory have not replaced human intuition with formalized procedures, but actually enhanced the players' intuition with new tools and concepts, including the key notion of a positional style incorporating a new kind of a weight function. The concept of positional play shaped a new decision-making framework.[31] The domain of intuition still encompasses modifications of the general form of the weight function as well as plugging into this function the many diverse positional parameters and their valuations.

So, chess represents a system which is not amenable to a complete and consistent program linking the initial position with the final position (except for degenerate cases, such as *fool's mate*). The fact that chess is a relatively simple game (the final goal and the rules of interaction of a fixed number of pieces are well-defined) makes it an effective instrument in linking the various states of a system which does not yield to a complete and consistent program.

By virtue of its features, chess is a good *analogy* for the study of *protracted systems* that give rise to states that must be linked together. Talcott Parsons' (1961) attitude to chess serves as an example of an analogy with social systems.

The isomorphisms between chess and other systems are not limited to simple analogies. In fact, chess can be used as an *experimental* model to simulate these problems, for relative to the duration of many phenomena in the universe, chess is a short game that can supply plenty of experimental data derived from the many games that can be played in a limited amount of time.

History reveals many attempts to employ chess as a model. A version of chess called Kriegspiel was widely taught in the Prussian military schools and, subsequently, in some other countries. In the eighteenth and even nineteenth century every serviceman in Prussia (and then in Germany) had to know how to play Kriegspiel. Kaiser used to show up at Kriegspiel tournaments in full military attire.

To bring Kriegspiel closer to the actual combat situation, the chess board was transformed into authentic military map and the pieces were sculpted in the image of marshals, officers, etc.

Kriegspiel owed its popularity to the fact that it proved an effective testing ground for certain strategies successfully employed in real-life military engage-

ments, notably Prussia's victory over Austria in the six-week war of 1866. After its defeat Austria became engrossed in Kriegspiel. France's defeat in 1870 at the hands of the Prussians produced keen interest to chess among the French. After the Civil War Kriegspiel made it into the United States, notably in the navy and the Naval War College in Newport, Rhode Island.

Subsequently, as a result of Russia' defeat in the Russo-Japanese War of 1905 and Germany's defeat in the World War I. Kriegspiel fell into disrepute as a modeling tool for conducting modern warfare. However, interest in the game of Kriegspiel has not waned completely—employees of the RAND Corporation still enjoy the game during their lunch break.

Former world champion Botvinnik once claimed that his chess algorithm can be successfully employed to create a more effective economic system. Whatever the validity of Botvinnik's claims (with respect to the stated goals), I want to note that the notion of testing the ideas on a computer rather than live people holds a lot of merit.

Our discourse on chess as a prototype of *protracted systems*, which can be used for experimental verification of performance-enhancing methods, has come to an end. I believe the next chapters, which explore the concept of predisposition in the social, economic, and aesthetical domains, will shed new light on the significance of chess as a model of *protracted* systems.

NOTES

1. As Roald Hoffman mentioned:

> At the time, this polymer could be made only in tiny amounts in laboratories. My idea was that we could make it in quantity if the two alternating bonding positions for propylene imposed constraints that were mirror images of each other. This is the symmetry of chess pieces at the start of a game. For white, the queen is to the left of the king. For black, the opposite is true.
>
> My hunch was a long shot, but I selected a compound that had two six-carbon rings built onto each side of one of the five-carbon rings. A bridge connected the two five-carbon rings. The success of this experiment provided the first proof that both Dyachovskii and Cossee were correct: the charged metal atom was bringing about a chain migration that allowed this metallocene to produce syndiotactic material. Some veteran chemists at first refused to believe it. But again, the end of the chain, together with the constraints of the site's chessgame symmetry, was dictating the orientation of the monomer. As the chain migrated from one side of the catalyst to the other with each addition, new monomers inserted themselves in alternating orientations. (pp. 90-91)

2. The originators of this analogy (Tully, et al., 1992) stipulate in their article that: "In a blush of conservatism, the title of this article was altered from the first choice: 'A three-dimensional Chessboard Universe?' In our imagination, the Great Wall figurine is only a pawn and the warrior is a more important piece."

3. For many years, by analogy with genetics, chess has been treated as the *Drosophila* of artificial intelligence. The game of Go is recognized by many professionals in the field of AI as the successor *Drosophila* of chess (*Computers, Chess, and Cognition*, 1990.) George Johnson (1997) published a very interesting article concerning the present

state of Go and its comparison with chess. There is one leading statement in this article that I don't accept; "It will take another century or two before the computer can beat the world champion in Go." About thirty years ago a similar forcast was made for chess computering and it failed.

One of the key feature of Go is its greater complexity as compared with chess: Go has 10^{57} times more board configurations (*Computers, Chess, and Cognition*, 1990, p. vii). As John McCarthy (1990) mentioned: "Comparing the playing strength of the best Computer Go program with the playing strength of the Go World Champion, I estimate such a program to be twenty levels behind the Champion, whereas I believe that the best among computer chess programs is 'only' three levels behind Kasparov" (p. 236).

This level of complexity calls for new methods of analysis predicated upon the concept of decomposition.

> In human chess, a position is considered as a whole; it is not divided into parts (sometimes, an example of a part of the board helps illustrate a concept, but it is not vital). In Go, separation is absolutely vital. Searching all legal moves in a Go game tree must be discarded after a few plies only, because of their many ramifications and the consequences of their combinatorial explosion. Therefore, a Go program ought first to identify small groups of stones and conduct searches and evaluations regarding each of these groups separately. (McCarthy, 1990, p. 236)

It seems to me, that McCarthy underestimates the role of decomposition of a position in human chess. Masters pay a lot of attention to fragmentation of a position to flanks, the center, etc. and asses the value of these structures in terms of the possibility to fasten shift of strength from one structural part to another.

Let me also note that the game of Go features its own rather impressive real-life applications (see Boorman, 1969).

4. It is possible to inject chance into the game. In fact, as it is mentioned in (Birbrager, 1975), "originally chess was a game of chance, the outcome of it depending on throws of dice. Such games with the use of dice were played in India about two thousand years ago" (p. 8). In Europe chance was part of the game until the Middle Ages when the church, which was ill-disposed toward gambling, put an end to the practice.

5. I would like to remind the reader that a more complete exposition of my general conception of chess and positional valuation can be found in my book (Katsenelinboigen, 1989*a*). This chapter can be viewed as a sequel.

Much of the material is derived from the one-day seminar *Chess and Business* which I organized and which was held on November 2, 1991, under the auspices of the *Dynamics of Organization* program at the University of Pennsylvania. The seminar welcomed both the students enrolled in this program (all actually work in business) as well as university staff and students interested in the subject. The seminar featured two key lectures. One was presented by Dr. Murray Campbell of the IBM Thomas J. Watson Research Center and concerned the *Grandmaster Chess Machine*. Dr. Campbell is among the leading developers of Deep Blue, one of the most powerful chess computer programs in existence. I presented the second report entitled "Chess as a Multistage Game." Subse-quent discussions centered on our two reports.

6. Let me digress and say a few words about the gambits. As defined by Lev Abramov (Reti, 1981), "a gambit is an opening in which a player sacrifices some of his material in order to expedite the development of his pieces or gain a spatial advantage"

(p. 194). At first glance, a gambit might seem akin to a positional sacrifice. However, the key difference is that a gambit belongs to a well-explored class of positions. Richard Reti (1981) notes: "One should study the gambit thoroughly before playing it," meaning one should be familiar with the variations which follow the material sacrifice. As far as a gambit is concerned (or reactive methods in general), the problem of an explicit evaluation of a position does not arise. On the other hand, the player is in the dark when he ventures into a positional sacrifice. Since the future course of the game is not known, selective methods come to the rescue in determining the merits of the sacrifice in terms of future gains.

7. Richard Reti (1981) affirms that "Adolph Anderssen was the first Master to show the world the full power of a combination" (p. 6).

Morphy's contribution to combinational style is indisputable. However, he is remembered primarily as a player who advanced the cause of the positional style of play. As E. Lasker (1937) notes if one inspects the games played by Morphy (as Steinitz did) it becomes apparent that his combinations did not spring forth spontaneously like revelations, but emerged from gradually grooming the position for a combination (pp. 192-99).

8. In his analysis of a position where white enjoyed a two pawn advantage, Igor Bondarevsky notes, "the game is far from over, for white pieces lack harmony. This situation is not unusual; indeed, when one strives for a material advantage, the positional considerations recede to the background which undermines the coordination of the pieces" (Quoted in Lysenko, 1990, p. 44).

9. Quoted in Lysenko, 1990, p. 69; the developed version was found on the Internet by the program *AltaVista: Main Page* in the file "The Valuation of a Chess Position," created by Artem Tyurin.

10. The relation between a chunk and an aggregate is analogous to that between a system (subsystem) and an aggregate.

11. To jump ahead of myself, let me remark that one of the main reasons for the waning interest in gestalt psychology (which was highly fashionable at the beginning of the twentieth century and declined starting the 1930s) was the critical problem of evaluating gestalts that have been formed.

12. History of chess reveals another goal as well. In the Central Asian version of chess game as shatranj a win situation takes place "not only when a player checkmated or stalemated his opponent, but also when a king remained on the board with even a single or major peace against the opposing unsupported king" (Birbrager, 1975, p. 11).

13. This brings the following episode from the history of chess to mind. One time, the famous Adolph Anderssen was coming home from a tournament and stopped at a roadside tavern. Spotting the new guest with an intelligent expression, the owner who was a chess buff, insisted on playing him a game. The guest turned down the offer saying he didn't know how to play. The owner offered a quick chess lesson to his guest. Finally, the guest succumbed and the game began. While the visitor was a quick learner he was losing one game after another. Having suffered numerous defeats the guest offered to play without his queen. The owner was certainly surprised but accepted the offer. To his amazement he started to lose one game after another. To alleviate the tremendous confusion which befell the tavern owner, the guest explained to him the reason for his success: he removed the only piece that was hindering his game.

14. An excerpt from Howard Staunton's book (1935) is an example of establishing approximate semiconditional valuations of the pieces using techniques which bear the stamp of an analytical procedure (without actually explaining the crux of the procedure):

> An attempt to establish a scale of powers whereby the relative values of the

> several men could be estimated with mathematical exactitude, although it has frequently engaged the attention of scientific minds, appears to be an expenditure of ingenuity and research upon an unattainable object. So ever varying, so much dependent on the mutations of *position* which every move occasions, and on the augmented power which it acquires when combined with other forces, is the proportionate worth of this with that particular man, that it would seem to be beyond the reach of computation to devise a formula by which it can be reckoned with precision. But still an approximation to correctness has been made, and the result arrived at gives the following as the ultimate respective values:
> Pawn = 100
> Knight = 305
> Bishop = 350
> Rook = 548
> Queen = 994 (p. 34)

The great mathematician Leonhard Euler (1707-1783) also tried his hand at devising an analytical procedure to compute the semiconditional valuations of the pieces. As Emanuel Lasker (1937) mentioned, Euler, who was a great mathematician but a rather poor chess player, was able to determine the values of the pieces mathematically, and these values happened to correspond closely to the values representing the practical experience of great players.

The procedure used by Euler to determine the values of the pieces is not known. But Lasker points out that Euler's method "bears the seed of future discoveries" (p. 323). Lasker does not give reference to Euler's work, which could have been used to reconstruct his chain of reasoning using our present-day knowledge of the subject. (My own attempts to find this work were unsuccessful. I asked specialists on Euler from the East German Academy of Sciences but even they were unable to help me.)

Judging by Lasker's comments it is reasonable to assume that Euler used rather static positions to compute the values of the pieces, that is, a case where material plays a decisive role. Two beginners playing in a random-ike fashion start from a given position and play *n*-games (*n* approaching infinity); material advantage for either side is determined by the winner of the match. Lasker also notes that for Euler the mobility of a piece was probably the dominant characteristic in establishing its material value. Mobility, in turn, is determined by the free space or by the obstacles (thus a knight, although it is less mobile than the bishop, has an advantage over the bishop in being able to jump over the barriers set up by the opponent).

15. For example, many grandmasters would disagree with Robert Fisher's assessment of two bishops as equal to half-a-pawn (Lysenko, 1990).

16. This is akin to searching for focal points (in various systems) or singular points in mathematics. By focusing on these critical points, one can manipulate the entire manifold more effectively.

17. Quoted from Michail Botvinnik's book (1987, p. 65). Peter Romanovskii's book was translated into English in 1990.

18. Michail Botvinnik's definition runs counter to the definitions proposed by several other players, including Gregory Levenfish. Botvinnik responded vehemently toward Levenfish's criticism. His arguments went far beyond the substance of the issue. The criticism of Levenfish (Jewish by blood) undertaken by Botvinnik's (also Jewish by blood) was imbued with political innuendoes smacking of the chauvinistic obscurantist press of the time. For instance, Botvinnik accused Levenfist that if one were to follow his

advice, the Soviet chess masters would not have accomplished the great feat of winning the world championship, a task assigned to them by the Party and the Soviet people. Botvinnik spiced his criticism with charges that Levenfish overestimates the role of Akiba Rubenstein (a Jew by blood!) in the history of chess in Russia, whom Levenfish judges to be on par with Michail Chigorin and Alexander Alekhine.

Take notice, this criticism of Levenfish was published by Botvinnik in the Soviet journal *Chess in the U.S.S.R.*, vol. 9, 1951 during the height of Stalinist dictatorship, growing Russian chauvinism, and the flip side of chauvinism—a war on cosmopolitanism (i.e., the reign of anti-Semitism).

19. Such statement have been challenged by John Geanakoplos and Larry Gray (1991) on the basis of the concept *When Seeing Further is Not Seeing Better*.

> The Shannon algorithm for game play by computers, which we will describe below, is based on the belief that seeing further is seeing better, and so comes firmly down on the side of calculation at the deepest possible level in a decision tree. But when sight is cloudy at best (as is the case when a computer looks at any given chess position), is this belief justified? Since the Shannon algorithm does not make any allowance for its own imperfect vision, we think not, at Ieast not all of the time. In fact, we have discovered several ways in which looking ahead can be misleading, as well as ways in which it can be helpful. (p.1)

The authors offered five general principles to improve the chess computer program by cutting some branches of the tree game. But these principles were not enough constuctive to be implemented in a chess computer program. Unfortunately, as I was told by one of the authors, they did not further elaborate their ideas.

20. The term is assigned by analogy with decomposition methods in mathematical programming. The technique is implemented in the following manner: the system is broken up into blocks having degrees of freedom. Each block selects an optimal solution based on its internal resources, a criterion, and external constraints obtained from the center. Each block sends its decision to the center. Having received all this information the center reexamines its criteria and the constraints and sends it back to the individual blocks. Each block reevaluates its previous decision based on this new information, and the new iteration begins. This iterative procedure converges when the solution generated by each individual block matches the optimal solution for the system as a whole.

21. Quoted in Lysenko (1990), pp. 58, 61.

22. I talked to a number of grandmasters regarding the Karpov's and Kasparov's styles of play. Provided I understood them, the difference in the present context is that Karpov, a very strong overall player, has been notorious since his early days for his brilliant strategic plans. At the same time, he has suffered sometimes as a result of the problems with tactical execution. Kasparov manages to beat Karpov because of his superior ability to reconcile excellent strategic plans with tactical execution.

23. If we play a mathematical game with these two definitions of positional and combinational styles we could formulate the following "social theorem":

If a hierarchical system is headed by combinational-style leader, then it is impossible to have positional-style leaders at the lower levels of the hierarchy: the former will dispose of the latter.

Stalin may serve as a good example of this type of arrangement. He would clamp down on fundamental research (even in science) if the research did hold promise of immediate practical results. *Lysenkovshchina* was largely an outgrowth of this attitude.

Genetics promised no immediate gratification while Lysenko's approach pledged specific results within a brief period of time. (For the same reason Khrushev also supported Lysenko. As far as I know, military people who supported genetics for bacteriological weapons purposes stepped in, which lead to Lysenko's downfall). In 1948(?) Stalin was gearing up for an assault on mathematics and only some attendant circumstances prevented this oncoming onslaught.

The converse of the above "theorem" is also plausible:

If a hierarchical system is headed by a "positional style" leader, then it is possible to have both "positional" and "combinational style" leaders at the lower levels of the hierarchy.

Combinational style manager is one who can be entrusted to implement specific practical tasks invested with a well-defined material goal and a program of execution.

24. In a private conversation, Grandmaster Maxim Dlugy expressed some interesting ideas regarding the formalization of strategic plans in positional play.

25. Reti (1981) writes: "At the time Morphy was exploring the open games, Steinitz focused on the laws governing closed positions. Their choice is not accidental, for every master pursues a style which befits his personality. Morphy's open style betrays his love for freedom of action and immediate gratification. Steinitz, on the other hand, sought stable and enduring values rather than fireworks and fast results" (p. 27).

26. This does not mean that the established assessments are rock solid. In his lecture at the aforementioned symposium Boes Weinstein noted: "Minutely explored positions that have been regarded as being equal for 50 years undergo reevaluation. A novelty! Often novelties induce anxiety. One person could completely revamp an entrenched mode of thinking. In the recent world championship match Gary Kasparov played the Scotch Game that has not been part of the grandmaster repertoire for decades. His ideas charted a new path. Since Kasparov has repeated the opening on many occasions, it has come back into vogue."

27. The following analogy should underscore the difference between the game as a conflict and as a competition. Scholars feature two kinds of discussants, provisionally termed *combatants* and *discussants*. The combatant must pin his opponent to the ground and rejoice the victory. This category of scholars may achieve impressive results, for the fighting spirit bolstered by their faith in being always right invests them with a lot of energy. The key flaw afflicting this group is that victory may cause them to become saints with all the ensuing consequences. Moreover, the combatants seek to surround themselves with somewhat inferior milieu so they can exercise their intellectual superiority. In addition they seek out people willing to elaborate on the idea which they impose, as well as pick easy to handle opponents. Discussants pursue the goal of expressing their opinion on the subject and enriching it with the ideas expressed by others. As a result, they are more open and thus try to surround themselves primarily with people of the same caliber—people, able to understand and enrich their ideas to the benefit of both parties. The discussant group can achieve no less results. However, endowed with calmer personality the discussant may cede to the combatant in terms of energy and spunk.

Are combatants better than discussants? Given the fact that scholars posses innately different personalities, it seems the answer must support an environment in which the two types can coexist peacefully.

28. There is a well known story of one outstanding chess player, namely Michail Botvinnik, managing to draw against another brilliant player David Bronstein. Their game was postponed in a position lost for Botvinnik. When Botvinnik was gearing up for a long over-the-board struggle he had the habit of bringing to the game a thermos with coffee. Botivinnik arrived to the game in question with his thermos. Bronstein decided

that Botvinnik's home analysis produced a saving variation. This confused Bronstein so much that after a several moves he was forced to agree to a draw.

29. Let me quote Lasker's (1947) speaking on the Steintiz' positional style:

> How novel, how surprising, how opposed to every sentiment of his time the conceptions of Steinitz must have been becomes manifest when in play over the games of the greatest match won by him, the one against Zukertort. Zukertort relied on combinations, and in that field he was a discoverer, a creative genius. For all that, in the majority of the games of the match, though he had lost none of his faculty, he was unable to make use of it, the positions yielding no response to his passionate search for combinations. Steinitz seemed to have the mysterious capacity for divining combinations long before they were realizable on the board, to encourage combinations favorable to himself and to forestall those which were unfavorable. Thus Zukertort, the great discoverer, searched in vain, whereas Steinitz, rather a poor hand at combinations, was able to foresee them. Zukertort could not understand how Steinitz was able to prevent combinations nor how he could win by such a method, since up to that time—this seemed to Zukertort indisputable—games, fairly won, had been won by fine combinations. Zukertort tried for four years to solve this riddle, but he never approached its solution by even one step, and he lost the mastery that he possessed into the bargain. He died a comparatively young man. (p. 197)

30. Ariel Mengazini's (1992) mentioned: “What now appeals to me most is the occasional game that displays what could be called a shift in the paradigm. It need have nothing to do with sacrificial brilliance. It pertains to fresh positional assessment, a way of handling the position that flouts traditional wisdom and is powerful enough to impose the creative vision (or revision) on the opponent.”

31. I would like to suggest a slight revision of the meaning of terms *combinational style* and *combination* and their relationship to the term *positional style*. Perhaps the term *combinational style* can be used in situations where a well-defined material goal and program are sufficient, that is, where it is not necessary to take into account the whole value of the resulting position. Such an understanding of the combinational style is, to a great extent, in accordance with the history of chess, that is, with the times that preceded the appearance of the positional style.

The term *combination* could be used to recognize situations where, first of all, a well-defined narrow goal is set; it is very important to not that this goal can be both a material parameter and a positional one. Second, a combination assumes the existence of a program that completely and consistently links the goal with the starting conditions.

From this point of view, it is clear that a combination can accompany the positional style and concerns not only its positional parameters but also its material parameters. Gain of the material will, however, always be treated in the frame of a position as a whole.

3

SOCIETY

The term *societal* refers to the entire society as a suprasystem. The more narrow social domain is marked by the term *social system; the economic domain,* by the term *economic system;* and *political domain,* by the term *political system.* For the sake of simplicity, the term *system* will refer to the societal suprasystem as well as to the social, economic, and political systems.

CONTRAST BETWEEN SOCIETAL SYSTEMS AND CHESS

Chapter 2 delved into chess as a protracted indeterministic system. The analysis of the various styles of play (particularly the positional style) and their synthesis is highly pertinent to societal systems.

A societal system is predicated upon protracted processes involving the interaction among people and between people and nature. Generally speaking, these interactions do not yield to a deterministic scheme. Societal systems also feature diverse structures, which engage diverse methods of operation. The societal system with "time out of joint" raises the same fundamental questions as chess, namely how to link the current state with the future (or the past).[1]

Societal systems share some characteristics with other systems. As for the role of predispositions, they also possess features that are unique. The key distinction is their greater *scale* and *diversity* of pieces and rules of their interaction, and, perhaps most important, the *dynamics* inherent in societal systems, which is defined by internal as well as external causes. Since chess embodies certain simplifying assumptions described in chapter 2, I shall qualify my adoration of chess as a model for the study of the concept of predispositions.

The following facets distinguish societal systems from chess:

1. In chess the rules of the game are defined *externally*; the only entity external to a societal system is nature.

2. Chess dynamics is channeled along a well-defined course, notably the quest for victory, and victory itself is encapsulated in a well-defined final goal; namely, the capture of the opponent's king. By contrast, societal systems lack one exclusive course of development, not to speak of a *single, final goal*. If preent, the goals (oftentimes fuzzy) or the course of development may be incorporated into some individual parts of the system. In terms of the system's convergence versus divergence, *chess* is inherently *convergent*, while *societal systems* are free to *converge and diverge*.

3. Chess is a closed system—all the pieces are exposed and there are no surprises from undisclosed sources (Hoffman, 1987).[2] As a result of their *openness* (or *closedness*) societal systems are affected by a myriad of unforeseen events, which tends to make their operation much more complex.

4. In chess the set of pieces and the rules of their interaction are both fixed. Over the course of the game, societal systems produce *innovations* including new types of social institutions, new technologies, new methods of operation, etc. Innovations originate in the R & D, which has become an integral part of a social system. While innovations yield to a complete and clear-cut description at the final stages, notably at *the level of routine operations*, the intermediate results (particularly at the initial stages) are rather *nebulous* and *ambiguous*.

5. In chess the pieces are not alive. Pieces lack individual goals. They are merely assigned functions that they must fulfill; they do not age or produce new pieces or new rules of interaction; they do not make their own decisions.

The pieces in a societal system are real people. The primary manifestation of this feature is that social systems possess internal goals with respect to the organization as a whole as well as its individual members. These goals also change over time, that is, the system and its individual are purposeful (Ackoff, 1980). People evolve and evolve differently. It is hard to predict the future course of events, so the predisposition social worth of an individual is hard to ascertain.[3]

6. In chess the material parameters are fixed. By contrast, the positional ones arise during the course of the game.

In social systems, both the material as well as the positional parameters are regarded as a given. The latter is evidenced by the fact that every individual possesses a unique innate set of positional parameters, that are manifest in one's emotions and their respective valuations. This pair encapsulates the relationships among the living creatures and the environment—relationships that have formed (and been reinforced) over the course of evolution. At the same time, social systems feature a conservative (traditional) set of positional parameters and their valuations manifest in the moral code and the laws. There is a peculiar interplay between these traditional and the innate set of positional parameters. As individuals and societies evolve, new positional parameters and their valuations are formed which interact with the established, that is, inherited (traditional) ones.

7. Taking the above into account, the chess and the social systems are distinct in the way a given state is formed and transformed into another state.

In chess the initial state is defined over a set of material parameters. In the social domain, the initial state is defined over a set of material parameters as well as the inherited set of positional parameters and their valuations.

In chess, the reactive as well as the combinational styles engender the transformation of material parameters; positional parameters are not explicitly incorporated in the process of transformation. It is only when we need to evaluate a position, which is characteristic of the positional style, that the positional parameters and their respective valuations are incorporated explicitly into the state of the system and the decision-making process.

In the social domain, whatever style of development is selected, the transformation of one state into another requires that the material parameters as well as the inherited (and possibly newly formed) set of positional parameters and their valuations be taken into account.

8. In chess you have to wait your turn to make a move (players alternate moves). In societal systems, there is no need to wait before taking action, which brings up the issue of the total time allotted for the game and time allotted for a single move. In chess, the time required to actually make a move once the decision is made is negligible (perhaps, with the exception of blitz, where the split second required to make a move may cause one's flag to fall). In societal systems, the actual execution may take a long time.

Similarly to the processes which take place in societal systems, a chess game could last indefinitely, at least in theory (some correspondence games do take months to complete). And just as in chess, where there is time limit for the entire game as well as for the first forty moves, in societal systems, decisions regarding key issues (such as a national plan of development) as well as more narrow problems (as specific as the duration of a business meeting) are also subject to time constraints. Moreover, societal systems are more exacting in terms of time because the competition does not have to wait for your move before it can take action.

9. Since the duration of a single chess game is relatively short, a given player can carry out his plan from beginning to end. In societal systems, the lack of final goals, the duration of the social processes, and the limited life span of the leaders (not to speak of their still shorter appointment at a given position) result in the *relay effect*. There must be continuity as the policy enacted by one leader is picked up by the next. The diversity in the types of leaders as well as in the mode of the transfer of power makes the transition very complex.

10. While they share certain features, the relationship between the chess players (during the game) and the relationship among members of societal systems are quite different. Chess is typically informed by *competition*. As far as the result is concerned chess is a zero-sum game (win-lose); there is no such thing as a compromise between the players during a given game. The player who has to reconcile or choose among the various alternatives consents to a very minor compromise. In chess all moves are planned and executed by the same person based on his abilities and his personal system of values. Societal

systems feature a variety of relationships among people, including *collobora-tion*, *cooperation,* and *conflict.* Compromises of all shapes and colors are commonplace. This diversity gives rise to two more outcomes, namely win-win and lose-lose.

11. A system is driven by vertical and/or horizontal mechanisms. Vertical mechanism involve subordination; horizontal ones are predicated upon parity of the interacting parties (Katsenelinboigen, 1988).

As a form of competition, the chess game can only be carried out via a horizontal mechanism (a vertical mechanism which controls the players is meaningless). In a sense, the mechanism is reduced to a degenerate case of a player controlling himself. Each player, in turn, manipulates his pieces in a vertical fashion. Since the pieces lack any autonomy, they interact solely by means of a vertical mechanism. Societal systems feature sovereign "pieces," as far as nature and other people are concerned. This autonomy leaves room for both vertical and horizontal mechanisms of performance as well as their mix. These mechanisms may encompass the system as a whole or be limited to some subsystems.[4]

My last comment concerns the chess vernacular and its pertinence to societal system. In the previous chapter I used the terms "combinational style" and "combination" interchangeably. Rather, the term "combinational style" will be reserved for situations where the goal directed at winning a particular piece is set and a program to achieve the set goal is elaborated. The term "combination" can be applied to positions where any well-defined goal, be it "winning" a material or a positional parameter, is set. Secondly, the term combination presumes that a program to attain the set goal is elaborated. Thus, a combination goes hand in hand with the positional style of play, but the gain of material (positional) parameter in this case is always analyzed in the context of the position as a whole.

With many key differences between chess and societal systems notwithstanding, chess has frequently been used as an analogy for social systems. For instance, using the simple model of chess, Talcott Parsons (1961) introduced certain important social categories such as values, roles, collectivity, etc. which were then employed in the analysis of more complex systems.

Let me quote from Parsons:

> The essentials of the interaction situation can be illustrated by any two-player game, such as chess. Each player is presumed to have some motivation to participate in the game, including a "desire to win." Hence, he has a goal, and, relative to this, some conception of effective "strategies." He may plan an opening gambit but he cannot carry advance planning too far, because the situation is not stable: it is contingent on the moves made both by himself and by his opponent as the game proceeds. The basic facilities at his command consist of his knowledge of the opportunities implicit in the changing situation; his command of these opportunities means performance of the adaptive function. Hence, at the goal-attainment and adaptive levels, goals are defined and facilities are provided, but specific acts are not prescribed. The facili-

> ties are generalized, and their allocation between the players depends upon each player's capacities to take advantage of opportunities.
>
> In turn, the meaningfulness of the goals and the stability of the generalized pattern of facilities depend on the existence of a well-defined set of rules, which forms the center of the integration of the system. The roles, in this case, are not differentiated on a permanent base; rather, the rules define the consequences of any given move by one player for the situation in which the other must make his next choice. Without such rules the interactive process could not be stable, and the system of adaptive facilities would break down; neither player would know what was expected of him or what the consequences of a given set of moves would be. Finally, the differentiated and contigent rules must be grounded in a set of values which defines the nature of a "good game" of this sort. (p. 41)

Erik Leifer (1991) dedicated an entire chapter to the social theory of skill. Here, "the chess game is not treated as a metaphor, as is common in social science literature, but as a real phenomenon" (p. 48).

Herbert Simon (1982*a*), a Nobel Prize Laureate in Economics and a chess expert, has made extensive use of the parallels between decision making in chess and in economics.

In a brochure devoted to chess and business Rudyard Istvan (1984), the vice president of the Chicago office of The Boston Consulting Group, cites a number of interesting chess techniques (gambits, for example) that are relevant to business. (The brochure does not discuss the conceptual stratagems found in chess and discussed in chapter 2 of this book.) Andrian Slywotzky (1996) strongly recommend the usage of chess for elaboration corporate strategies because they require to think of several moves ahead. Unfortunately, it was done in very general terms. The concept of amalgamation of different styles during the chess game and in particular the concept of measurement of a chess position, that are especially important for business, have been missed. Jerry Wind (1997) emphasized on the role of chess in creating preemtive corporate strategies.

In 1992 Banker Trust undertook an interesting experiment to attract gifted chess players to the world of finances (Ross, 1995). The bank placed a "jobs ad" in *Chess Life* and a number of other game publications. The ad solicited more than 1,000 responses, mainly from chess players. The bank hired five people. Of four very gifted players, two (grandmaster Maxim Dlugy and senior master Giromo Bono) still work in the financial sector. The most successful member is the international chess master Norman Weinstein, who achieved some very impressive results in the foreign exchange department of the same bank and who attributes his success to chess.

I can cite other examples of chess players turned successful businessmen, for instance, grandmaster Ronald Henley runs his own options-trading firm, Tumbleweed Trading (Ross, 1995).

The relevance of chess to social systems is certainly not limited to metaphors and analogies or the involvement of chess players in business. Chess may come to be utilized as an experimental device in social systems. Former world champion Michail Botvinnik (1992) alleged that his chess algorithm can be used to construct a more effective economic system. Justified or not, the very notion of testing some general ideas on a computer rather than live human beings is truly amazing.

All of the aforementioned features make the implementation of indeterministic processes in societal systems more complex than in chess. Let us now examine this process from a systems perspective.

CATEGORIES OF DYNAMICS OF SOCIAL SYSTEMS

Defining Development

The term *dynamics* is used as a generic term to describe the behavior of a system. In the general case, a societal system is a self-governing system that possesses degrees of freedom in selecting its course of dynamics.

In the very simplest case (of we abstract from all other variables) dynamics engenders the dichotomous category of *existence*, that is, existence versus non-existence. Our focus will be on the "path of existence."

Here, dynamics may be enhanced by the category of *change.* Change, in turn, evokes such attributes as notably depth, breadth, frequency, etc.

Another dynamic attribute of change is its *sign*, that is, *progress* versus *regress*. For the sake of simplicity, I shall stick to the term *progress* (*regress* is analogous except for the reversed sign). The notion of degree is particularly pertinent to progress, for it reflects the contribution of the current state to the development of the system as a whole.

The concept of dynamics elaborated by Russell Ackoff (1994) may serve as the groundwork for our analysis. This concept incorporates the most general attributes of system's dynamics as system's existence as well as the changeability, the sign of the latter, and the extent (degree) of contribution of a given state to progress.

This concept becomes more tangible by differentiating between the categories of *survival*, *viability*, and *growth*, on the one hand, and *development*, on the other.

Here, *survival* denotes a state of existence, a mere prevention of the system's demise. It implies zero contribution of a given system toward progress. *Viability* implies that the system's output exceeds expenditures. *Growth* features positive rates of change of the relevant parameters. *Development* is a more "fuzzy" category, but it does incorporate survival and viability as the preconditions, and may, at some stage, feature growth as well.

Ackoff (1994) defines *development* as: "*an ability and desire to satisfy one's own needs and legitimate desires and those of others*" (p. 45).

I believe this definition lacks the general systems significance and is limited to social systems. For example, it does not apply to the animal kingdom, for according to Ackoff the *desire* is a conscious impulse.

Prior to attempting a general systems definition of development, let me make a digression into biology, a field in which the category of development plays a crucial role.

When speaking of biological development, we should distinguish between development in the sense of construction (development of a biological unit based on a *fixed program*) and development which incorporates *change*. The former is commonly known as *embryonic* development. The latter is best characterized by the term *volutionary* development. Volution is termed *evolutionary* if it unfolds slowly and *revolutionary* if it proceeds at a rapid pace.[5]

By analogy with biology, let me propose a general systems definition of development: development is a form of dynamics, which creates *predisposition* for change. One key attribute of developmental dynamics is multiple-level programs, that is programs for changing other programs (until we reach the zero-level program, which defines the behavior of a system).

As pointed out in chapter 1, development is a multi-stage process and each stage features its respective methods of operation. Development also engenders a stage which deals with the creation of predisposition. A state (of a system) formed on the basis on this scheme creates favorable conditions for future develop. On the other hand, this stages establishes no precise definitive link between the predisposition of a system and the future course of events.

Directions of Development

To repeat myself, in contrast to chess, societal systems lack both the final goal as well as the general course of development: both categories represent unknown variables.

The eternal question *"Quo vadis?"* (Where are we going?) echoes mankind's inability to decide on the meaning of life and, consequently, on the course of development. No matter which path one proposes, there is an equally tenable path leading in the opposite direction. Even in the extreme case of mankind's objective being limited to mere survival, there exists another equally general and conflicting goal, namely that mankind strives for self-destruction.

In Tolstoy's famous story "The Kreutzer Sonata" (1968) Pozdnishev, who is the conduit of some paradoxical conceptions on the meaning of life, maintains that carnal love is an inequity which inflicts all kind of suffering upon man. The character who tells the story responds very predictably by saying that forbidding carnal love is unnatural, that "if you considered this to be a law, the human race would soon stop," to which Pozdnishev replies: "Why should it be continued?" (p. 341).

Defining the true course of mankind's dynamics does not become any easier at the metalevel. The poem "Two Tales" written by a Russian poet Vassily Zhukovksy tells of a wise man Kerim, whom his patron sultan questions on the meaning of life. Kerim apologizes to the sultan for not being able to answer this

question and embarks upon a long journey to hear what other wise men have to say. But their answers are all different. In a nutshell, some say that man strives for earthly pleasure and lives to his heart's content; others say that man seeks pleasure, ignorant of the sin and imminent death lurking behind his back; still others say that human life is totally meaningless. Kerim is left in the dark, for each response begets an equally tenable converse response. As he approaches the royal chamber upon his return home, he has a revelation:

> Our life is a wandering round the world,
> Just like my own, in fulfillment
> Of the supreme will of sovereign Lord.
> In reply to Kerim the King said:
> Faithful friend, be my father from this time forward.[6]

The story, in a nutshell, is that the meaning of life is the *search for the answer to the question* of the meaning of life. But even this metasolution may be challenged by the converse metasolution, namely not to seek an answer to this question.

To sum up, societal systems feature uncertainty with regard to the true goals of mankind as well as the true path of development. This is the realm of *complete uncertainty* characterized by unlimited diversity of possible and equally tenable (undifferentiated in terms of value) lifestyles. The dilemma facing mankind defies a solution. At the same time, it is *unavoidable*. In a sense, the development of mankind is *in general a completely deterministic* system, but the outcome is *complete uncertainty*.

The practical merit of all these deliberations is to affirm that the search for the meaning of life is futile, and that the departure from this earth is, in principle, not a tragedy. Under certain conditions (for instance, if the discontent with life overpowers the instinct of self-preservation) the above statement may ease one's untimely farewell.

If nothing else, the very powerful instinct of self-preservation makes people seek a personally acceptable way of life. How are all these divergent trends reconciled within the societal system?

The societal system features a growing array of alternative lifestyles that are supported primarily by mutually independent institutions. At this stage the law of the excluded middle does not apply. At the next level when we have more certainty, the diversity inherent in a particular institution is restricted, at which point we can speak of a preference for some particular alternative (i.e., priorities). Indeterminism remains an integral part of the mechanism of operation, for the choice of some particular program may be rejected. As the opportunity for rejecting a given alternative wanes, the degree of indeterminism also declines. Ultimately, as the set of programs is narrowed down and the choice becomes well defined (particularly with ritualized lifestyle), we can speak of complete determinism. Here, the conditions are ripe for concentrating all effort on the optimal execution of the alternative selected. A monk in a monastery is an example of such extreme case.

Divergence and Convergence

It follows from our discussion that the history of mankind features a combination of divergent and convergent processes with the preponderance of divergent ones, particularly when it comes to selecting the direction of development.

Divergence does not preclude determinism. If divergence is inevitable, as is typical of rigidly branching Markov's chains (for instance, certain chemical chain reactions), it becomes deterministic. The general case, however, is indeterministic and it features different stages. Convergence, on the other hand, tends toward determinism, that is, unavoidable program-like procedures aimed at a well-defined final state. The actual methods of implementation of a convergent procedure may be indeterministic, especially when the targeted state cannot be achieved using a uniform complete and consistent program (chess serves a prime example of this type of a convergent process).

To simplify things a bit, the various paths of development of mankind are captured by the divergency of hierarchically structured *ideologies*. Principal religious and secular ideologies (such as Marxism) that are at the top of the hierarchy will diverge at the lower levels of the hierarchy. For instance, as Christianity evolved, it branched out into such major faithes as Catholicism, Protestantism, Orthodox church, Armenian-Gregorian church. These, in turn, split up into denominations. Protestantism alone features a dozen major denominations (Luthe-ran, Calvinist, Anglican church, Methodist, Baptist, Adventist, etc.) with each denomination further subdivided into subdenominations. Judaism has also evolved into five major faithes: Hasidic, Orthodox, Conservative, Reformist, and Constructivist.

As we go down the ideological hierarchy, convergent processes (ones featuring a common goal) become more pronounced. The ideologies tend to turn eschatological and the divergent methods shift toward the domain of the *means* of achieving the goal rather than the goals themselves.

Islam, Christianity, and Buddhism spotlight the final goal—paradise (the former two) and nirvana (Buddhism). Judaism, as presented in the Torah, is not eschatological: it neither postulates an afterlife (Judaism lacks the concept of a soul as separate from the mortal body) nor does it define the goal of life "here on earth." As I see it, Judaism provides a direction for one's conduct. As an individual in body and in flesh a Jew pursues his own interests to lead a happy life on earth within the guidelines prescribed in the Torah. These guidelines are manifest in the various rules which reflect the need to take the interests of other people (including gentiles) into account.

The communist and the fascist ideologies feature their respective ultimate goals of forging a society of universal well being. The desire on the part of some countries to dominate the world (oftentimes justified by their eschatological best ideology) was an attempt to take the convergent trend to an extreme.

Preserving and expanding the manifold of ideologies in no way prevents any given nation from choosing a specific ideology which best fits their needs. The only requirement is that their choice be compatible with the preservation and expansion of the ideological diversity in the world as a whole.

The last decade, notably after the publication of Francis Fukuyama's 1992 work, witnessed a lively debate surrounding the global trend to converge to a democratic political system, allegedly the most effective political system. In my opinion, the primary trend to this day is divergence, meaning the formation of distinct political systems. Naturally, in a volatile environment the countries will make concessions and attempt to restructure their political system in order to improve their performance under the new conditions.

Take the history of Russia, for example. Its size and ambitions coupled with the fact that a large share of the Russian population gravitates toward an authoritarian regime, tends to push the country toward an expansionist aggressive policy. The implementation of this strategy calls for *concentrating* all resources on specific goals that go beyond just higher output of military hardware. A no less important objective was to launch heavy industry and mold each and every enterprise to serve military objectives; the peace-time output of many enterprises was a by-product of their primary product line.

Stalin forged the largest and the strongest empire in Russian history. It made the world tremble, and it instilled pride in the hearts of many Soviet people from all walks of life.

As long as the Soviet system met its objectives, it was adequate. However, after World War II the U.S.S.R. pitted itself against the entire civilized Western world and, starting in the mid-1950s, against China as well. The burden proved too much to handle. With the depletion of resources, the Soviet economy began to slip at the end of the 1970s. At the same time, Western rearmament during the 1980s (including the Star Wars project) challenged the Soviet aggressive policy and overstretched the Soviet economy.

The country was facing a serious dilemma: converge to a democracy or preserve the old system and try to resolve internal problems by expanding into new territories, such as the oil-rich states of the Persian Gulf? Michail Gorbachev, who came to power in 1985, started down a third path. He was determined to preserve the authoritarian regime and the nucleus of the empire using flexible rather than despotic methods. The fallout of his policy was to relinquish the outer edges of the empire—states such as Nicaragua and the satellite states of Eastern Europe. On the domestic front, the communist party was stripped of its long-held monopoly and a multiparty system began to emerge; U.S.S.R. held parliamentary elections with more than one nominee per seat (replacing a rubber stamp parliament and appointed deputies). The role of the centralized planning mechanisms was curtailed and a number of market-type institutions began to take shape; the country became more open to tourism and even emigration. At the same time, Gorbachev held strong to his personal power eschewing direct presidential elections, manipulating the parliament, keeping control over strategic decisions such as war and peace, and trying to secure the core of the empire (recall the bloody events in Armenia, Georgia, Lithuania, when the Soviet empire was threatened with disintegration).[7]

At first glance, the approach taken by Gorbachev to jump-start the country resembles a democracy. However, in essence his method represents a recourse to more flexible means of governing the country and securing his personal

power. In making an early diagnosis of the country's policy, it is crucial to distinguish between democratization and flexible methods of preserving an authoritarian regime. It turns out that such flexible methods lack stability, especially if one seeks to preserve an empire-oriented regime. This path invariably leads either to a democracy or to backlash, a reversion to a harsh authoritarian system. If democracy wins out, its long-term success hinges upon the way the country moves toward a democracy.

When he took over the reigns of power at the end of 1991 Boris Yeltsin initiated some key measures aimed at demilitarization and liberalization. He largely dismantled the Soviet empire, interjected a multi-party system into the Russian-Soviet empire, and pushed a sizable part of the economy into a market environment, etc. But all of these changes have been made without any profound strategic plan—just by common sence and improvizations. Meanwhile in a time of deep changes of the tradition of a country, and that is case of transforming Russia from a military to a peaceful contry, a strategic plan based on nontrvial concept, is especially important. The absence of such a plan can bring degradation of the country and return it to the previous authoritarian regime.

It seems to me, the initiatives taken by Yeltsin aggravated the ochlocracy and anarchy in Russia, created a pseudo-market and ensuing social and economic degradation.The country now seems to react by gravitating toward the traditional authoritarian regime, as manifest in the growing role of the communist party, the popularity of Alexander Lebed, and so on. The oncoming political regime need not be a tyranny, the likes of Ivan the Terrible, Peter the Great, or Stalin. Russian history witnessed long stretches of more benevolent authoritarian regimes, such as that of Alexander II, and Nicholas II. I don't mean to imply that democracy will forever elude Russia, but at this point Russia's predisposition toward a free democratic society is slim.

By the same token, China's convergence toward a democracy is far from certain. It seems that the Chinese aspire to establish a superpower within the framework of an authoritarian regime, but at this point the pace of their ambitions allows China to maintain some degree of flexibility. The present-day Chinese model is reminiscent of the blueprint for forging a powerful Russia that was put forth by Nickolai Bukharin at the end of the 1920s. The country was to follow the ironhanded totalitarian path charted by Joseph Stalin.

Ordering the Historical Process

Analysis of history, where divergent and convergent processes live side by side, raises the question of whether there is an order to historical development.

The liaison between the *past* and the *future* invariably has been a point of contention in the social sciences community. There is a profound disagreement among the historians regarding the mode of the “temporal link”: some historians (a minority), particularly those aligned with the school founded by the British philosopher and historian Thomas Carlyle (1795-1881), argue that each historical situation is unique and that the past is severed from the future in the sense that the historical patterns as well as historical analogies are inadmissible as a

credible blueprint for the future course of history. As they perceive it, the task of the historian is to investigate a concrete historical situation.

The majority of historians does recognize the existence of historical patterns or succession, which might serve as the bridge between the past, the present, and the future. One common fallacy is to interpret the past in terms of wishful thinking for the future: as the Russians jokingly say, nowadays it is really hard to predict the past.

Assuming history is subject to certain trends, what form and shape do these trends assume? Are they linear or cyclical or of another curvature? Marxists contend that history unfolds in a linear fashion as one social modality is replaced by a more progressive one: there is a progression from the primitive communal system to a slave-owning system to feudalism to capitalism and finally to communism. A consistent adherent to this theory would have to vindicate the slogan discovered in a cave from the primitive-communal era: "Glory to slavery, the glorious future of all mankind!"

The more established approach proffers that historical trends are of cyclical nature. This theory has been championed by many prominent historians from Giambattista Vico (1668-1744) to Arnold Toynbee (1889-1975). More recently, this concept has been incorporated into the theory of Russian history put forth by Alexander Yanov (1981).The criteria defining a given cycle may vary. For instance, in my article (1980) I suggested that history can be viewed as a superimposition of the historical cycles experienced by different countries. The principal criterion is the shift from extrovert (top priority is changing one's environment—the external world) to an introvert mentality (emphasis on altering one's inner world).[8] The duration of these cycles varies, so the historical process represents a peculiar braiding of superimposed cycles experienced by each country over the course of time.

There is a great temptation to find "the laws of history" and historical analogies certainly promote a better understanding of the present as well as help chart the future course of action. However, this tempting path is fraught with traps. Analogies are predicated upon similar historical realities, but in practice each period is unique. The fundamental question that arises in this respect is: Which features unique to a given historical setting can be abstracted, so the new situation warrants a justified comparison with the one from the past?

Presumably, history is not a chain of random events. By the same token, history is not a rigidly determined process governed by Her Majesty's Fate. One needs to exercise extreme caution in distilling past trends and applying them to chart the future course of development. Moreover, in case this kind of extrapolation is not doable, it makes sense to introduce the category of predispositions, which shows the impact of the unique current situation (which has incorporated the past) upon the future. It would interesting to examine the rise of fall of great empires, the appearance of tyrants, etc.

METHODS OF OPERATION OF SOCIETAL SYSTEMS

Comprehensive Method and Method of Disjointed Incrementalism

Societal systems operate based on two methods (or an amalgam of the two). The two polar methods, as formulated by Charles Lindblom (1959), are the *comprehensive* method and method of *disjointed incrementalism*. Disjointed incrementalism consists of isolated steps with minor progress being made at each step. This method resembles the step by step positional style and looks as an indeterministic one. Comprehensive method parallels the intrinsically convergent, which features a program-like sequence of steps toward the goal that governs the search process. In a nutshell, the cornerstone of the comprehensive method is to work out programs to reach an optimal state from a given state. This method looks as a deterministic one.

In the domain of social systems, the comprehensive method might seem better adapted for creating a diversity and then selecting from it; hence, a complete and consistent program of action is the prerogative of the comprehensive method. By the same token, method of disjointed incrementalism is, by definition, fraught with incompleteness and inconsistency because it entails autonomous actions of individuals and a search for a compromise.

Karl Popper (1971) laid the philosophical groundwork arguing against the use of comprehensive methods in social systems, equating them with the programs pursued by communists and fascists. Popper dubbed this class of methods utopian engineering. His argument against the methods of utopian engineering in social systems is based on the idea that these systems are not amenable to a *verification* of the proposed blueprint for an integrated dynamic society, that is, it is impossible to find *sufficient conditions* which would ensure that the proposed scheme does in fact lead to the desired results. Popper's alternative to *utopian engineering* in social systems is *piecemeal engineering*—a variation on the theme of disjointed incrementalism. Another advantage of disjointed incrementalism is that the resulting outcomes are more easily *reversible*.

Actually, the comprehensive method is predisposed toward the combinational style but is not synonymous with it. Chess has shown that the modified comprehensive method (meaning not necessarily complete and consistent) is effective for *strategic positional play*.

In the more complex cases, the comprehensive method may come under the guise of a *plan*. I believe the most original presentation of the planning process is found in the work of Russell Ackoff (1981).[9] Ackoff's conception lays out the following scheme: the dynamics of a social system follows a multistage *purposeful* process that commences at the end. Each stage of this multistage process features its own ways of setting the purpose and linking it with subsequent stages. Preceding the planning process is a *mess*, characterized by an assemblage of the various components comprising the system and isolated interrelations among these components. This mess represents the raw substrate upon which certain constraints and forces that drive the development of the system are formulated.

At the initial inaugural stage of planning, the purpose is an *ideal*. What distinguishes an ideal from a utopia is that the former can never be attained and is subject to change. Moreover, the link between an ideal and the subsequent stage is by no means apparent. At the next stage the purpose is an *objective,* which

may be rather remote but it is attainable. This stage also lacks a clear-cut link with the subsequent stage. At the next stage the purpose is a *goal*. The goal is attainable and it can be linked in a program-like fashion with the stage initial conditions; at the same time, the chain linking it to the objective is not definitive.[10]

I took this scheme a step further and introduced new stages housed between the goal and the initial state of the system. The purposes of these new stages are termed *aim* and *target* and both yield complete program-like link.

Figure 3.1 illustrates the interrelation among the stages of the planning process.The link between the ideal, the objective, and the goal is characterized by "time out of joint." It is precisely at this pivotal stage that the category of de-

Figure 3.1
Bridging the Purposes

Presence of program-like procedure linking the purposes	Attainability of the purpose	
	Unattainable	Attainable
No link	Ideal	Objective
Only with subsequent stage		Goal
With previous and subsequent stage		Aim
Only with previous stage		Target

velopment comes to the fore and must enlist the calculus of predisposition. On the other hand, goal, aim, and target are linked in a program-like fashion, that is, via extrapolation or optimization. The latter methods figure prominently when measuring growth, that is, in assessing the link between the initial state and any state en route to the goal.

The next question is the mapping of the purpose of any given stage of planning onto the purpose of the subsequent stage.

I would venture to say that within the framework of *development*, in the general case any purpose will map onto the purpose at the next lower stage in the form of predisposition. This point helps avoid the temptation to match long and short term goals.

The following example will hopefully shed some light on this statement. Suppose a company sets a remote (say, ten years) objective to become the leader in some field. This does not mean that the goal for the fifth year must also incorporate leadership in the field. It is precisely the uncertainty of the next five years that drives an organization to create by the fifth year the predisposition for attaining its long-term objective.

The multistage blueprint for planning elaborated by Russel Ackoff parallels the deterministic-indeterministic phase-transition scheme I described in chapter 1 of this book. In both cases the process kicks off from a *mess*; the stage of *ideal* corresponds to the chaos phase; objective to predispositioning; goal, aim, target to programming.[11]

The described planning scheme fuses comprehensive method with the method of disjointed incrementalism, that is, flexible comprehensive method and method of disjointed incrementalism may compliment each other.

The described game of chess suggest that the cornerstone of the game is the comprehensive methods of play contingent upon a strategic plan; methods of disjointed incrementalism are subordinated to the strategic plan.

The same approach to playing the social systems is conceivable, but it is fraught with grave dangers that are extremely difficult to overcome.

To conclude this part on the two methods of operation of a societal system, I would like to bridge these methods with the respective mechanisms of implementation which we observe in action in political systems.

The comprehensive method, that cultivate programs of growth, tends to promote the concentration of effort upon the attainment of the set goal, which, in turn, invites authoritarian systems with vertical mechanism, that is, a centralized control, piramid-like governing system.

In a nutshell, democratic systems tend toward the creation of predisposition for development. Democratic systems predicated upon the horizontal mechanisms resemble a trapezoid, that is, the macrolevel is a plateau at which the activities of various independent institutions (executive, legislative, and judicail branches; multi-party system; free press, etc.) are coordinated via the method of disjointed incrementalism. As Charles Lindblom (1959) notes, "Democracies change their policies almost entirely through incremental adjustments. Policy does not move in leaps and bounds" (p. 84).

However, the ever-growing turbulence of the democratic systems and the political/ecological environment may be incongruous with disjointed incrementalism. The future development of democratic systems may call for wider use of flexible comprehensive methods. We should not wait till the last moment to elaborate these methods. The current situation reminds me of the economic mind-set in the West until the mid-1930s, when the reigning economic doctrine was principle *laissez-faire, laissez-passer.* The severe crisis which struck the entire Western world caused certain constraints to be imposed upon this principle and spurred the introduction of a highly intricate mechanism of state regulation. This mechanism preserved and nurtured the market as well as tamed the powerful spontaneous forces characteristic of the market. It was precisely because the concept of such a flexible mechanism was elaborated by John Maynard Keynes ahead of time, that such countries as United States and England were able to weather the economic calamities that befell them.

Two Examples of the Methods of Operation of Societal Systems

The examples presented below illustrate two opposing ways for implementing the comprehensive method and method of disjointed incrementalism via program like growth of a system and creation of predisposition respectively.

The first example explores the platforms of two political parties operating with the framework of a democratic society from the standpoint of the methods

of operation proposed by these parties (the interparty conflict is outside the scope of my analysis).

The two parties I have in mind are the social-democratic and the communist. Both sprung from same womb of Marxism and the ultimate mission of both parties is to attain the greatest possible social welfare and justice.

The key feature that distinguishes social democrats from the communists is how the two evolve, or proceed, in the direction they choose. The communists tend to embrace the program-like method and its respective combinational style (to borrow the chess term); social democrats lean toward the method of predispositioning and the corresponding positional style.

The communist doctrine is predicated upon the assumption that there is a final attainable goal. Communist slogan "to each according to his needs and from each according to his abilities" endeavors to engineer a paradise on earth.[12] Communist contend that the high level of output achieved under capitalism makes the attainment of this goal realistic; at the same time, the capitalist institution of private property leads to anarchy. Private property not only detracts from the best possible allocation of resources, but it also leads to the plundering of wealth. The remedy is simple: abolish private property and set up a plan-based system that will construct and implement complete and consistent programs of *growth*. Assembling such a plan-based mechanism is a technical matter, for the entire system may be viewed as one huge enterprise; full coordination at an enterprise can be extended to the economy as a whole.

Even in the industrially backward countries the communists took to concocting programs to build communism, for they knew the level of output sufficient to attain their goal. Moreover, the communists thought their program of growth and their assumptions about the environment very realistic; their timeframe for attaining the final goal was very short—one generation.[13]

So, the *goal is clear-cut*. Now the task is to channel all the resources into attaining the goal; so, it is only logical that the communists sought to introduce a period of transition, namely a highly centralized political regime, en route to communism. The communist credo impelled them to introduce a dictatorial regime as soon as they came to power. Actually, these regimes pursued expansionist policies and served to augment the personal power of the leaders; the communist ideology was merely a camouflage. The consequences of these social experiments are known all too well. Who can say now which came first: the chicken or the egg?

Social democrats stressed long-term development aimed at creating a more affluent and fair society. The cornerstone of their program was not the ultimate goal—too remote if present at all—but the direction of development. Eduard Berstein, one of the leaders of social democrats, spoke these famous words: "Movement is everything, the goal is nothing." This maxim espoused by social democrats committed them to the preservation and development of a free society and its democratic institutions. Such a political system was deemed conducive, not so much to the elaboration of specific programs, but to the creation of predisposition for development.

The second example concerns U.S. policy toward China in the 1950s and 1960s and the war in Vietnam. Unlike the previous case, this example reveals the advantages of the comprehensive method as compared with the method of disjointed incrementalism.

I realized from my conversations with some people at the state department that this organization is suspicious of comprehensive concepts. These speculations are seen as interfering with practical decision making. Instead, the state department opts to observe the situation as it develops and make the decision within the framework of disjointed incrementalism (i.e., take specific actions to address the problem or improve U.S. global political standing).[14]

Perhaps, this approach to foreign policy works well in dealing with tactical issues that are unlikely to have major repercussions. My task here is to show the flaws of the method of disjointed incrementalism as manifest in the Sino-American relations and the Vietnam War in particular.

The main argument advanced by the American leaders for engaging in a war in Vietnam was the need to arrest Chinese aggression when it was still in its infancy. In the early 1960s the West justifiably regarded China as posing a threat to peace. The war between North Vietnam and South Vietnam fueled by China was perceived by American politicians as a Chinese threat, at least to the Asian continent. This impelled the United States to intervene directly to try to check China's expansion. However, the events which began to unfold in China in the early 1960s cast some doubt on Chinese expansionist tendencies. By the mid-1960s, or more precisely by 1966, it became apparent that China was making a radical shift, eschewing expansion for some time to come. Nonetheless the American government pursued the war in Vietnam for another seven years.

Let me dwell a little on the evolution of China after the Communist takeover in 1949. My argument calls for a brief digression into the distinct history of ideology in China over the course of several thousand years.

Some preliminary remarks concerning the scope and the frequency of changes in a hierarchy of ideologies are in order. The higher the level of an ideology (the more general it is), the more deep rooted and stable are the principles that define it. This serves to safeguard the human psyche. By reinforcing itself, an ideology transforms into a stereotype of consciousness of the masses of the country. This stereotype becomes an immutable dogma and all opposing views are perceived as madness. Thus, it is unusual and painful for a given country to switch to an opposing ideology, as revealed by the shift from introvert to extrovert ideologies and vice versa in such placees as India and Europe.

China is a notable exception to this conservative streak. Confucianism, which was founded in sixth century B.C., is generally thought to represent the extrovert facet of Chinese ideology. The following example should elucidate my point.

> In one of Chuan-Tse's books, it is said that when one of Confucius' disciples saw a gardener who was carrying water (which he used to get from the well by means of descending into it with his jar every time) to the garden in order to water his flowers, the disciple asked whether he

> would like to facilitate his work. "But how?" asked the gardener. Con-fucius' disciple replied, "You have to take a wooden lever, whose front end is heavier, and the other end is lighter. Then you would easily be able to scoop water out of the well. Such a well is called the well with a crane." The gardener, who was a sage, said: "I heard how my teacher used to say that if a man uses a machine, he performs all his deeds as a machine. One who performs all his deeds as a machine develops a machine heart. Then the one in whose heart a machine heart is beating forever loses pure simplicity."[15]

The struggle and fusion of the extrovert ideology of Confucianism and the introvert anti-Confucianist sentiments run through the many centuries of Chinese history; perhaps this factor has informed the rather frequent ideological shifts in China. I venture the following speculative remark: the historical tradition of ideological shifts has allowed for rapid ideological change over in modern-day China. The following facts bear witness to these transformations.

When the communists, headed by Mao Tse-tung, seized power in the late 1940s they launched a marked transition toward an extrovert ideology. Confucius was held in high esteem.

In foreign policy, extrovert orientation became manifest in China's expansionism. It suffices to mention China's involvement in the Korean War, provocation on the border with India, aid to North Vietnam which fueled its aggressive policy, and so on.

China's domestic policy unfolded along the following lines. Mao embarked upon a course of intensive industrialization, but due to China's inability at the time to pursue industrialization on its own, he was willing to endure the aid provided by the communist Soviet Union. With Mao and Stalin both aspiring to world domination and Mao acknowledging Stalin's greatness, the interests of the two dictators did not clash. However, by the mid-1950s when, following Stalin's death, Mao exalted himself as the leader of the communist camp and decided to persevere with Stalin's policy of world domination, he encountered stiff opposition from the new Soviet leadership. Soviet leaders refused to give up their hegemony in the communist world but they were not prepared to wager a new world war. Under the circumstances, Mao could not expect the Soviets to assist him with industrialization, not to speak of supplying him with atomic weapons. Pursuing industrialization through closer ties with the West, particularly the United States, would have detracted from China's prominent global status.

The only other venue was to rely solely on the China's own potential for industrialization. Mao banked on China's own capacity to develop and at the end of the 1950s he announced the policy of the *Great Leaps Forward*, which was to confer unparalleled greatness upon China by the late 1970s. The major component of this program was increase in steel production to close to a billion tons a year—a task to be accomplished by spurring home metallurgy; that is, by installing a small steel furnace in every household. Agricultural output was to be dramatically increased by taming nature. Water, "our friend and enemy", was to be transformed into an absolute friend. Dams were to be erected that would not

only prevent flooding but also permit major land irrigation projects and the construction of hydroelectric power plants. These dams were to be constructed with China's own resources (i.e., primitive manual labor).

As we know, Mao's program of the great leap forward ended in a complete fiasco. The quality of home-made steel was poor, and the first major floods toppled the crudely built dams.

The ensuing predicament served to fuel the political struggle in the country as different plans centering on the future course of China's development clashed. For our purposes, it is interesting to trace the various alternatives proposed by different factions vying for power.

Faced with a difficult dilemma, the course Mao had chosen in his struggle for power was to remain outside the conflict between the two superpowers—U.S.S.R. and the United States, letting them tear each other apart. Deprived of the resources needed to support extrovert development, Mao decided to revert back and resurrect the traditional introvert facet of Chinese culture.

The Cultural Revolution, staged by Mao Tse-tung in 1966, marks a transition toward an introvert ideology. Freezing industrial growth was accompanied by certain other measures, including the relocation of huge numbers of urban dwellers to the rural areas, drastically reducing the requirements placed upon students' professional education, reducing the role of the material incentives in the industrial sector, etc. During this period Confucius becomes the target of sharp criticism.

The cultural revolution was extensively discussed in the literature throughout the world. However, the facet of the revolution which drew most attention was Mao's political struggle to hold on to his power rather than the country's reversion to the introvert ways. It goes without saying that the situation in China following the period of the great leap forward impelled Mao to eliminate his political rivals who were proponents of the extrovert culture and called for cooperation with either the Soviet Union or the United States. Nonetheless, the ideological means employed by Mao in his struggle for power were ignored. The opportunity to employ the transition to an introvert culture as a weapon in the struggle for power arose precisely because China inherited this versatile combination of introvert and extrovert cultures. It is hard to imagine the leaders of either the United States or the Soviet Union resorting to a major shift in cultural orientation as a practical alternativee route in their struggle for power.

China's transition to an introvert culture was to impact not only its domestic but also its foreign policy, manifest primarily in the renunciation of expansionism. In my opinion, the failure of American politicians to recognize this trend and their emphasis upon the political struggle for power in China lead to the escalation of the Vietnam War, which proved so dismal for the United States. The false diagnoses articulated by the American politicians made it impossible for them to recognize early on the limited nature of the events in Vietnam and steered the United States into an unpopular war, eventually decided in North Vietnam's favor. At the same time, in the early 1970s the U.S. policy toward China makes a dramatic turn as the United States attempted to

create yet another antidote to the U.S.S.R., the archenemy of the United States at the time.

Following Mao's death the new government began to steer toward an extrovert ideology. Against the background of four thousand years of imperial China (with expansionism occurring in cycles), the present-day authoritarian regime is fraught with the revival of an aggressive policy that would avenge this great country's anemic performance over the last few hundred years.

As China embarked upon the extrovert path, its key aim was to create predisposition for industrial development rather than pursue direct industrial growth and military might. To this end, the development of agriculture and the service sector was largely delegated to the private sector. The material incentives to work were restored and scholarship became respected once again. Higher education at universities was endorsed and tens of thousands of Chinese students and graduate students were sent to study in the West. The trade between China and the West grew rapidly. Massive reparations subsided during the period although the country stuck with an authoritarian regime intolerant to dissent.

The 1990s mark a new stage that features industrial development on a mass scale and the influx of foreign capital. However, the authoritarian regime endures and even becomes somewhat more repressive. I think it would be fair to say that the rapidly expanding industrial base is geared primarily toward building up military strength. There are many reasons for the most recent shift in China's policy, of which I shall mention two. First, all the necessary infrastructure (relatively advanced agriculture, light industry, and trade) is in place. Second, the collapsed Soviet Union, for good reason, feared a strong China since China lays a claim to the Chinese territory taken away by Russia. I would like to remind the reader that in the mid-1960s the Soviet Union gave serious consideration to launching a preventive war against China. The United States was interested in maintaining a global balance and was not inclined to permit a Soviet nuclear attack on China. In all likelihood, the Chinese leaders took into account the threat posed by the once powerful Soviet Union.

The ideological shift of the late 1970s has not really altered the American policy toward China. Only in the last few years have American politicians expressed concern over the events in China, particularly in connection with the threat to Taiwan. However, no real measures are being taken to check the growth of this new military monster. America still pursues broad-based cooperation with China by allowing large-scale private capital investment in China as well as imports from China. (Chinese trade surplus allows them to use the hard currency to buy modern military hardware and, more important, the technology for its production from Russia.)

Thus, the awareness of the ongoing historical clash between the introvert and the extrovert ideologies in China may help us recognize the decisive factors which define global political situation and point to some measures that might prevent the emergence of a new militant giant.

PREDISPOSITIONS

The structure of the weight function, which measures predisposition toward development of a societal system, is similar to the one used in chess. The key distinction between the two is the valuation of essential and positional parameters.

Research into the dynamics of societal systems has given rise to such overlapping notions as *social development, social change, social indicators,* and *quality of life*.[16] All these theories incorporate the notion of predisposition which features similar essential and positional parameters as independent variables.[17]

For instance, the set of social indicators (*Handbook on Social Indicators*, 1989) covers a wide range of human activities, including population composition and change; human settlements and housing and geographical distribution of population; households and families, marital status, and fertility; health and health services; impairment and disability; nutrition; learning and educational services; economic activity and population not economically active; socioeconomic groups and social mobility; income, consumption and wealth; social security and welfare services; leisure and culture; communications; and public order and safety. Each category can be broken down into subgroups, which, in turn, can be broken down further until we arrive at elementary social indicators.

In effect, the indicators listed above include only positional parameters, leaving the economy as the domain of essentials. For the most part, social indicators denote interrelations, notably the simplest type of interrelationsthat is, the *structural parameters*, which I regard as ratios between the essentials. For instance, along with the cursory structural parameters like the mortality rate, birth rate, and per-capita consumption of various nutritional items (calories, proteins, etc.), there are more detailed parameters like birth rate by age of the mother or ethnic group; supply of calories and protein as a percentage of minimum per capita allowance, etc.

As the scope of social indicators is expanded to include parameters reflecting human relations (including the interrelation between the authorities and the various social groups), a more complex class of parameters emerges, which I have termed *characteristic parameters*. These are loosely defined as the features characterizing the process of interaction among the objects; for example, substitutionality of objects, compatibility of objects, universality, the relative location of objects (proximity, centralization, openness), and the actions performed by or upon the objects (monotonousness, traditionality).

Figure 3.2
Types of Human Interaction

Means	Ends	
	Incompatible	Compatible
Compatible	Collaboration	Cooperation
Incompatible	Conflict	Competition

The variety of relationships governing the interaction among the participants of a societal system can be grouped into distinct classes. Russell Ackoff [18] has proposed a four-tier classification of human relations based on copartnership and rivalry among the individuals.

The class of rivalry-type interrelations, which figures prominently Figure 3.2, includes conflict and competition. The difference is the compatibility of ends and means (for instance, competition arises from compatible goals and incompatible means). Rivalry entails replacement of obsolete modes of operation. Rivalry also keeps tabs on the actual performance (mode implementation) of an organization (in this context, an organization is synonymous with a labor collective). Depending on its performance, an organization may be replaced (perhaps partially) or forced out altogether. An organization also stands to lose certain benefits (in the broad sense of the word) to which its employees have grown accustomed. It seems that the resulting negative incentives are more powerful to affect change than the positive incentives of a better future.[19]

Of course, the interrelations among people are not limited to rivalry[20] but involve forms of copartnership[21]: collaboration and cooperation.[22] The prevailing mode of interaction is largely determined by the predominant *culture* of a given society. Perhaps, the culture is, in turn, largely defined by that society's principal ethnic group.[23]

I propose two groups of parameters which define the culture of the predominant ethnic group in terms of the described modes of interaction. One facet is craving for leader(ship) who can instill order and express the collective will of the population; the second factor is the individual's ability to work without compulsion. Assuming each parameter is binary (yes/no), the two generate four possible combinations shown in Figure 3.3

Figure 3.3 suggests that the various combinations of the two parameters which shape the culture of the ethnos are inexorably tied to the predominant mode of interaction in the country. For instance, market economy seems to thrive in countries dominated by people capable of working without compulsion. The market economy, in turn, hinges upon another variable, namely the craving for a leader(ship). Countries where the prevailing trend is a poor ability to work without compulsion must feature an external coercive body, a frail free market mechanism, and an economy dominated by some form of state control.

Further on in the book, I will discuss the modes of interaction in different societies by comparing American (Anglo-Saxon) firms with Japanese and Ger-

Figure 3.3
The Sources of Cultural Differences Among Different Countries

Craving for Leadership	Capacity to Work without Compulsion	
	Yes	No
Yes	Japan, Germany	Russia
No	United States, England	Non-viable culture

man firms. At this point, let us examine human rights as an example of a characteristic positional parameter in social systems.

Dissident Movement

In the totalitarian state that was Soviet Union, the dissident movement of the 1960s serves as an example of the creation of predisposition for transforming a system dominated by a program-like doctrine to a democratic society. My interpretation of the dissident movement makes no claim to represent the views of the participants, who are certainly free not to share my opinions.

Following Stalin's death and the limited political liberalization of the country, the liberally minded contingent of the Soviet intelligentsia sought to find a way to promote a free Western-type society. The ideologues of this movement—Alexander Esenin-Volpin, Andrei Sakharov, Valentin Turchin, Valery Chalidze, Boris Shragin, and others—realized that the new society cannot be crafted in a programmatic revolutionary manner.[24] Forming such a society is a laborious process and each step must be underwritten by creating a predisposition for success at the previous step. The primary task formulated by the dissidents was to forge the one crucial constituent component of predisposition toward a free society, namely the notion of an *individual* aware of his rights and willing to take personal responsibility for his actions. It should be pointed out that the movement targeted civil rights, not socio-economic rights. It is precisely the civil rights which mold the individual who aspires toward freedom and is willing to pay by taking responsibility for his decisions. Socioeconomic rights, on the other hand, embrace government guarantees for certain benefits, such as employment, free medical care, etc., but in return the state begets a citizen who is proportionally obedient to the benevolent government.

The dissident movement itself was organized around precisely this mission to secure civil rights. It was based on openness and recourse to legal means upheld by the Soviet Constitution (which was ignored by the authorities). This movement lacked an all-powerful center—it was more like a constellation. Andrei Sakharov, while greatly respected within the dissident movement, was certainly not its sole leader.

Compare this arrangement with the pre-revolutionary practices of the communists in Russia and in China. They had a clear-cut objective, notably to gain power, and this attitude informed their subversive activities, the creation of a single rigidly structured party, and the highly inflated role of the party leader. This contrast exposes the key difference between the predominantly combinational policies of the communists and the positional play of the dissidents.

Dissident movement in the U.S.S.R. proved that there are forces in the country that are mature in their struggle for a free society and that are capable of proposing nontrivial methods to attain their objective. The goal of securing human rights appears to have defined the social background of most dissidents. The movement was limited primarily to the intelligentsia, and intellectuals at that, for whom human rights represents a basic value (as opposed to rank-and-file technical intelligentsia including doctors, engineers, teachers, etc.). With

independent entrepreneurs out of the picture, most other social strata in the U.S.S.R. were concerned primarily with socioeconomic rights.

Soviet authorities invested a substantial effort to dismantle the dissident movement and largely succeeded in doing so: some dissidents were exiled abroad, some were sent to the labor camps and psychiatric clinics, some were paid off.

As marginal as it was, the dissident movement made a tremendous impact on the sociopolitical life in the country. It was important in laying the groundwork for the policies later pursued by Michail Gorbachev and his circle.

Unfortunately, when the opportunity to make major strides in the realm of political freedom finally presented itself, the dissident movement was ill-equipped to propose a similarly non-trivial approach to further its aspirations of creating a democratic society. In other words, the dissident movement failed to come up with a broad-based platform to create predisposition for a successful transition to a democratic society. Neither did the dissidents elaborate a program to underwrite a direct single-leap transition to a democratic society. Perhaps, the reason for these miscarriages lies in the nature (direction) of the dissident movement as well as the natural selection of the people involved in the movement (certain types of personalities), or the movement's ultimate suffocation at the hands of the Soviet authorities.

As a result, dissidents were caught off-guard when Gorbachev came to power and announced his program of *glasnost,* which granted the creative intelligentsia real opportunities to express their views. However, the proposals advanced by the intellectual circles at the time were rather trivial and superficial because they put them in the beginning while they have to be achieved on the end and avoiding the development a transitional path to these ends. These proposals, in particular, aimed at improving the system by eliminating the Communist Party (at least its monopoly over state affairs), offering several candidatesd in parlamentary elections, open the country, to abolish censorship, dismantling the State Planning Committee, distributing land to the peasants, introducing private property, privatizing industry, etc.[25] Gorbachev's ploy to employ flexible methods of control by vacillating on the implementation of the above proposals ultimately lead to the disintegration of the country, escalating anarchy, and to his own ouster.

Once Boris Yeltsin came to power, he pursued a more consistent policy with regard to the aforementioned proposals first all based on demilitarization. However, it turned out that even in this less restricted environment, the lack of non-trivial ideas and tenacious recourse to the oftentimes superficial ones lead in to an erosion of the social fabric (crime wave, pervasive corruption, etc.) and economic decline. It appears that the urgent need to put an end to these negative trends has sparked calls for the creation of an authoritarian regime in Russia, this time under the right wing banner (albeit moderate at this point).

In short, the failure of the intellectual circles to formulate a non-trivial reform agenda to take Russia to the next level of a free society has resulted in the many opportunities which arose during Gorbachev's and Yeltsin's reign being squandered away.

PREDISPOSITIONS (CONTINUED)

Manifold, Variety, and Singular Variety at Large[26]

A *manifold* is set of differernt elements that are unranked (i.e., indistinguishable in terms of preference or priorities). A *variety* is a set of prioritized elements, but with all the elements of the set preserved. A *singular variety* is a set of prioritized elements, with all elements outside of the select subset being banned. The ban varies as to severity, ranging from prohibition against the implementation of these elements-*singular variety of the first order,* to their total annihilation, which represents *singular variety of the second order.*

The *basic building block* of the category of development is a *manifold*. It is a set of initial different elements which inform the overall dynamics of a social system. A *uniformity* is an extreme degenerate case of a manifold where all elements are the same. The next stage involves the formation of a *variety*. A degenerate case of a variety (which strips it of its general significance) is *singular variety*. In the latter case, the set of alternatives is reduced to a single course of action. It is important to note that singular variety should not be confused with tactical decisions, which certainly pursue a single course of action at any given moment, but which also seek to preserve and expand the *manifold* and *variety*.

More specifically, manifold, variety, and singular variety interact in the following manner: the higher the level of a given system (in time or in space) in the hierarchy of systems, the more pronounced is the degree of indeterminism and the more important is the creation of a manifold. In other words, an effective *long-term strategy* worked out at the top levels of the hierarchy must be predicated upon in a manifold. At the lower levels of the hierarchy, the degree of indeterminism tends to decline and certain integrating criteria are introduced; still, the *variety* is preserved. This case is characteristic of *midterm strategy*. At the bottom levels of the hierarchy, which are dedicated to *tactical* tasks, the system becomes highly deterministic gravitating toward *singular variety*.[27]

One way to safeguard variety and manifold from destruction is to implant strategic constraints into the formulation of tactical tasks. This reveals the fundamental principle underlying the synthesis of the manifold, variety, and singular variety: given that short-term tasks tend to foster *singular variety*, it is vital to observe the strategic constraints, which preserve a *manifold* and *variety*.

The interplay among the three categories is well illustrated by the biological systems. For example, each specie features a *manifold* of mutations; a *variety* of mutations is distilled from this manifold based on the success of adaptation to a given environment; finally, certain mutations best adapted to a given environment are given preference, which results in a singular variety. The best-adapted mutation (singular variety) will merely assume the dominant position in the distribution of various mutations (variety), but, most important, the manifold of mutations is preserved.

How is diversity integrated in societal systems? What is the foundation underlying human interaction? A cohesive system must ultimately perform based upon a principle, provided the manifold of different individuals is preserved

(this does not preclude intermediate principles of integration for various groups). This same principle informs the global valuations for the system as a whole. While members of society may maintain their own system of values, they must conform to this single principle of interaction. Introduction of such uniform valuations underwrites the transformation of a manifold into a variety. The latter is a set in which certain elements are given priority over other elements, but no elements are eliminated from the set.

The following example should shed some light on this abstract scheme. According to the Pareto optimality principle, an exchange of goods among economic agents is permissible if one man's gain does not lead to another man's loss. Moreover, it is possible to determine the prices (not some average prices, but very intricate marginal magnitudes known in mathematics as Lagrange multipliers) which allow each participant to decide on the type and the amount of product he has to surrender in order to acquire other products, so as to maximize his utility without impinging on the interests of other participants.

This example reveals that a price system does not preclude individual preferences and individual-specific values assigned to the various goods. In other words, integration of system comprised of individuals engaged in the exchange of goods and services does not rule out differentiation among the participants. The more straightforward mode of integration is based on the unification of the values of all the participants, that is, matching completely the global price of a product and the valuation of this product by each participant.

The problem of integration would cease to be an issue if all the participants settled on one single principle of integration. However, this is the exception rather than the rule, for there are always people unwilling to conform to the established principle. Unanimity can be achieved only under highly simplified assumptions (such as Pareto optimality principle). In practice, if we allow for redistribution of income (say, between rich and poor countries), any single principle of income redistribution will be challenged. (The same considerations apply to ethical issues; see chapter 4 on ethics).

How is societal system to function in the absence of a uniform principle of integration?

In societal systems integration proceeds at several levels, one of which is the integration of different ethnic groups (assuming, of course, that the very notion of an ethnic group is valid).

In general, a given ethnos is defined by its biological attributes as well as the environment (geographical and social). It seems the emergence of the political institution of a *state* (country) with its own unique political system serves to promote the development of a given ethnos. The existence of many *independent* countries serves to reinforce this manifold of ethnic groups.

This *manifold* of independent states results in a paradoxical situation as the *manifold* may actually destroy or shrink itself. As countries seek to improve their lot, certain countries (perhaps, due to their success) begin to fancy they are exclusive with all the ensuing consequences, including the desire to conquer the world and impose the one legitimate world order. The presence of large coun-

tries with aggressive ideologies may threaten the manifold itself (to say nothing of its expansion).

Note, that the need to preserve the manifold of ethnic groups, to reinforce and expand it via the manifold of independent states is a matter of *faith*. The situation is paradoxical indeed, for one may profess the equally plausible idea of cosmopolitanism, that is, the need for all ethnic groups to intermix and spawn a single nation of the world. For better or for worse, cosmopolitanism is not the way to integrate the human race while preserving a manifold.

There are intermediate levels housed between ethnic groups (countries) and mankind; one important one being the notion of *civilization.* The resulting interplay between the ethnic groups and civilization spotlights another relationship, namely between culture and civilization. Vsevolod Zaderetsky (1990) notes that such thinkers as Oswald Sprenger and Nikolai Berdiaev perceived civilization as threatening to swallow individual cultures. Berdiaev makes the following distinction: "Culture is of national origin. Civilization is international. Civilization is mechanical. Culture is founded upon inequality, on qualities. Culture is aristocratic; civilization is democratic, etc."

It seems to me that civilization is compatible with cultural diversity within the democratic framework (not to be confused with ochlocracy). Democratic civilization (manifold) allows for a variet*y* of cultures provided no single culture inflicts excessive pain upon other cultures (within a given country, we can have public institutions, clubs, entertainment, even schools that are geared toward specific ethnic groups). Civilization also incorporates certain integrating parameters which, at least in theory, must ban those cultures which seek to destroy and make uniform the diversity of cultures.

The history of Hitler's Germany is characteristic in this regard. Its culture is not bad per se (being a constituent element of the manifold), but it is sinister because it sought to decimate other cultures both domestically and internationally (in countries under German occupation); in other words, it sought to institute a singular variety of the second order. At the Nuremberg trials, the advocates of this culture argued that their actions were grounded in the laws governing their unique culture. However, the court found the leaders of Nazi Germany guilty because they violated universal values espoused by Western civilization, which includes the peoples of many other countries and a significant part of the German population.

Naturally, the civilization does bear upon its constituent cultures in pursuit of uniformity. Nevertheless, within the framework of a democratic civilization this pressure should not prevent individual cultures, including the less prominent ones, from evolving and thus preserving cultural diversity.

The described principle of integration of manifold, variety, and singular variety in societal systems is also illustrated by the perennial debate between the radical liberals and radical conservatives centering on the coexistence of different ethnic groups.

As racists, radical conservatives not only underscore ethnic distinctions, but claim the superiority of one ethnos over another based on certain indicators. They go on to generalize and proclaim the universal superiority of one ethnos

and urge limiting or even eradicating the inferior ethnic groups; in the extreme case they seek to obtain a singular variety of the second order.

On the other hand, liberals who recognize the need to preserve diverse ethnic groups are unwilling to acknowledge a *variety*—situational priorities of one ethnos over another as judged on the basis of certain criteria. In fact, radical liberals purport that the variations among the ethnic groups are fleeting and caused solely by the environment, which propagates and aggravates the differences. Perhaps inadvertently, the radical liberals seem to advocate only *uniformity*.

It seems that we are putting ourselves in a tragic bind by opposing radical liberal uniformity and radical conservative (racist) singular variety of the second order.

Once we recognize certain ethnos-specific qualities (i.e., the manifold), we are in a position to promote the culture of each ethnos and then integrate them. Reluctance on the part of the liberal circles to recognize certain qualities peculiar to each ethnos (especially ethnic groups living in the same country) leads to a virtual imposition of the dominant culture upon all other groups, effectively transforming the country into a singular variety of the second order. The consequences of such an attitude may be rather dreadful.

The fact that racists spotlight certain ethnos-specific traits is not evil per se. Their vision is flawed because they ignore the fact that the differences are limited, meaning they fail to reflect the full range of qualities intrinsic to a given ethnos. Racists also tend to exaggerate the importance of certain traits; the pronounced value judgment is at best situational, for the performance of any given trait depends on the prevailing circumstances. A shift in the environment may cause certain traits considered negative to become positive. This rejection of variet*y* and propensity for singular variety of the second order may also lead to tragic consequences.

Manifold, Variety, and Singular Variety at the National Level

The problem of integration at the national level (within a given country) is certainly complex, for the development of the manifold is confounded by many factors even in secular and ethnically homogenous countries. At any given moment the country operates as a single entity. A single ideology must be selected from the manifold of ideologies, thus transforming the country into a *singular variety.* There are many ways to carry out this transformation ranging from the majority rule principle to unlimited power of the dictator. Whatever mechanism is used, it incorporates such categories as variety and singular variety of the first and second order.

In democratic systems, integration is predicated upon the majority rule principle. Suppose the majority gravitates toward an extrovert ideology, which allows an individual to fight and defend one's country. If a significant share of the given population espouses an introvert ideology which advocates nonviolence, then the majority would be forced to impose the ruling ideology upon the minority, in the sense that the minority would be allowed to profess and develop its ideology, but not to practice it—a singular variety of the first order.

Singular variety of the second order bans all ideologies except for the reigning ones; this situation is very typical of totalitarian countries.

In other words, in a democracy the non-conforming minority must be given a choice: either to develop its convictions but not practice them or be punished in accordance with the societal laws; ultimately, this minority must be granted an option to emigrate. This was the case at the end of the nineteenth century with U.S. Mormons who practiced polygamy. They were given an ultimatum: convert to monogamy or leave the country.

Take a country ruled by extrovert ideology, but with a small minority adhering to an introvert mind-set. If this minority is unobtrusive and can practice what it preaches without impinging on the majority, then it can be allowed to practice its beliefs. For instance, pacifists may be spared military service or be recruited into non-combat divisions. In case these groups are not too numerous, the country is in a position to promote a manifold.[28]

The interplay of manifold, variety, and singular variety becomes more complex if the *compatibility* of various subsystems comprising the system is also taken into account. The example used to elucidate this statement is the compatibility of various ethnic groups living under a single system.

Before we proceed I would like to digress and elaborate on the concept of compatibility, which has not been duly investigated as a general systems phenomenon. Compatibility may be understood as *substitutionality* or as *complimentarity*. The former is characteristic of the medical sciences. It was only in the twentieth century that major theoretical and practical strides have been made in the field of compatibility, notably in the classification of blood types so essential for transfusion, organ transplant, etc. The problem was relatively simple when it came to blood transfusion. Certain indicators representing essentials define one's blood type and compatibility (the blood of the people having the same blood type is interchangeable). The discovered criteria which define the blood type turned out to be sufficient, since the transfused blood is eventually replaced as the host organism quickly begins to produce its own blood. Organ transplant, including heart transplant is a lot more complicated. The heart transplant operation is fascinating not so much because of its technical merits, as the methodology it employs. The latter embodies a two-step procedure. The first step is donor selection, that is, finding a heart compatible with the host. Since the donor heart may still encounter a rejection by the host organism, the next step is to administer drugs to attune the transplanted organ to the host.[29]

These developments in the field of medicine are quite pertinent to the second facet of compatibility, namely complementarity, which surfaces in connection with the problem of compatibility of various ethnic groups.

Armed with the systems vision of compatibility, let us turn our attention to the complementarity of the various ethnic groups living in one country. Complementarity is a *two-stage* process—finding the proper donor and suppressing rejection-inducing factors. It is essential to distinguish ethnic conflicts arising from non-complementarity of the ethnic groups from those resulting from rejection of ethnoses that basically qualify as complimentary donors.

Another pivotal variable is the degree of *non-complementarity.* This parameter should not be confused with the *hostility* of one ethnic group for another, since non-complementarity of two ethnic groups does not necessarily entail hatred or mutual hostility (although there is usually no love lost between such two groups). In principle, the extent to which members of one ethnic group are non-complimentary or hostile toward other ethnic groups may vary.

While non-complementarity and hostility are correlated, ways of resolving ethnic conflicts are many and diverse. Once non-complementarity of certain ethnic groups is recognized we can work to attenuate the hostility to the level of non-acceptance, opting for a peaceful separate rather than perpetual confrontation. By the same token, an open dialogue may help ease the possible tensions between complementar*y* ethnic groups.

Hostility on the part of the dominant ethnic group toward a minority varies over a wide range of attitudes: from a desire to help the incompatible group leave the country with as little suffering as possible, to limiting the areas where the minority is allowed to live or the occupations which it is allowed to practice, to a policy of extermination. While the liberal perspective does recognize ethnic diversity and the need for the state to protect the various ethnic groups, it tends to spotlight features common to all of humanity and to attribute the disparities to socio-cultural circumstances. As a result, the liberal approach presumes that there is always a way to make any ethnic groups complementary.

Ignoring the key differences among the ethnic groups only impedes the very formidable task of creating an environment conducive to the development and subsequent integration of different ethnic groups.

The conservative perspective, on the other hand, acknowledges the existence of traits common to all humanity, but it underscores the distinctions and alleges that complimentarity is not always attainable. For instance, the conservative approach may maintain that the incompatible ethnic groups not be allowed to live under one roof. Under certain historical circumstances, this emphasis upon ethnic differences may ultimately lead to a value judgment (ranking of different ethnic groups), thus transforming the conservative view into a reactionary view characterized by racism, chauvinism, call for subjugation of all ethnic groups to one supreme ethnic group, and even the desire to exterminate the malignant ethnic groups.

Let me illustrate this hypothetical scheme using the relationship between Jews (as an ethnic group) and other ethnic groups as an example.[30]

Let me start by saying that I believe in preserving the Jews as a distinct ethnic group. I realize that my position is a matter of faith. However, the view to the contrary, namely that all ethnic groups ought to intermix and that assimilation is the true path to integration, is not dear to me because of the previously outlined philosophical considerations regarding manifold and singular variety.

What is it that makes the Jewish ethnos (or more precisely, that part of the ethnos which comprises its core, its critical mass) so distinct? What is its predisposition toward development which makes the Jewish ethnos relatively incompatible with many other ethnic groups, particularly if they all live in the same country? These distinct features of the Jewish ethnos encompass both the essen-

tial as well as positional parameters which reflect the interrelations as among the people, as among the people and God, etc.

One example of an essential parameter is the traditionally high regard for knowledge. This may be the reason why Jews rushed into Westerntype secular education as soon as they acquired an opportunity to do so. Apparently, not all ethnic groups aspire with the same fervor and on the same scale toward education and the opportunities it presents.

I believe the truly distinct characteristics of the Jewish ethnic group are embodied in positional parameters. Let me cite one example.

The values inherent in the Jewish mentality reflect parity between the Jew and the authorities. Presumably, Judaism agrees with the Jewish mentality, for it is highly improbable that there is no strong correlation between the mentality of the ethnic group and the chosen religion. It follows from the most sacred source of the Jewish faith, the Torah, that man is comparable to God as the master of the universe. This quality of the Jewish ethnos is not limited to God, but informs the attitude toward the environment, including the leaders.

I want to summon some passages from the Torah which I believe corroborate my statement regarding the Jewish attitude toward the authorities.

Authors of the Torah drew a concept of man as created in God's image and after God's likeness. God Himself is presented not as a frozen omnipotent, omniscient, and omnipresent force, but as an evolving entity. Man, endowed with creative powers and free will, augments God's power. It is by the people and through the people that God carries out the development of the universe (following its creation). In fact, the role of man is so great that God stands on a par with some chosen people and concludes a covenant with them. According to the covenant, God promises to multiply the nation coming from Abraham and make Abraham the father of many peoples; in return a Jew agrees to obey God's commandment which compels all Jewish men to be circumcised.

A sufficient condition for a genuine contract between man and God is that God acknowledge His own imperfection and recognize the greatness of man, recognize man as an independent force and man's indispensability. Moreover, the contract becomes more credible if some kind of equality, both physical and intellectual, is established between the two parties.

Man's physical strength is affirmed in the legend of Jacob's struggle with God (Genesis 32:24-32). God was unable to overcome man but could only inflict a minor wound: “and the hollow of Jacob's thigh was strained” (Genesis 32:26). And God said to Jacob: “Thy name shall be called no more Jacob, but Israel; for thou hast striven with God and with men, and hast prevailed” (Genesis 32:30). “And Jacob called the name of the place Peniel: 'for I have seen God face to face, and my life is preserved'” (Genesis 32:31).

However we choose to interpret this passage (even assuming that Jacob struggled not with God but with an angel), Man proved he could compete physically with a heavenly force.

Man's intellectual capacity is alluded to by the authors of the Torah in the story of Adam who, having tasted from the Tree of Knowledge, becomes God's intellectual equal. Unlike God, Adam is mortal and God banishes Adam from

the garden of Eden so he would not taste from the Tree of Life and become immortal. And the Lord God said: "Behold, the man is become as one of us, to know good and evil: and now, lest he put forth his hand, and take also from the tree of life, and eat, and live for ever" (Genesis 3:22).

The authors of the Torah tell other stories affirming the intellectual parity of God and man. When God became enraged at the disobedience of the Jewish people during their sojourn in the dessert and decided to annihilate and replace them with another nation originating from Moses, Moses argues with God and persuades Him to preserve the people.

> And the Lord said unto Moses: "How long will this people despise Me? and how long will they not believe in Me, for all the signs which I have wrought among them? I will smite them with the pestilence, and destroy them, and will make of thee a nation greater and mightier than they." And Moses said unto the Lord: "When the Egyptians shall hear—for Thou broughtest up this people in Thy might from among them—they will say to the inhabitants of this land, who have heard that Thou Lord art in the midst of this people; inasmuch as Thou Lord art seen face to face, and Thy cloud standeth over them, and Thou goest before them, in a pillar of cloud by day, and in a pillar of fire by night; now if Thou shalt kill this people as one man, then the nations which have heard the fame of Thee will speak, saying: Because the Lord was not able to bring this people into the land which He swore unto them, therefore he hath slain them in the wilderness. And now, I pray Thee, let the power of the Lord be great, according as Thou hast spoken, saying: The Lord is slow to anger, and plenteous in loving kindness, forgiving iniquity and transgression, and that will by no means clear the guilty; visiting the iniquity of the fathers upon the children unto the third and fourth generation. Pardon, I beseech thee, the iniquity of this people according unto the greatness of they mercy, and as thou hast forgiven this people, from Egypt even until now." And the Lord said: "I have pardoned according to thy word." (Numbers 14:11-20)

The Jewish attitude toward God as, in a sense, an equal, the defiance and rejection of idols, are all manifest in the Torah in a very critical attitude toward the leaders of state. Evidence for this can be found in the sermons addressed to the Jews during their plight in the desert. The sermon was about the future king of the Jews once they come to the Promised Land.

> When thou art come unto the land which the Lord thy God giveth thee, and shalt possess it, and shalt dwell therein, and shalt say: "I will set a king over me, like as all the nations that are round about me"; thou shalt in any wise set him king over thee, whom the Lord thy God shall choose; one from among thy brethren shalt thou set king over thee; thou mayest not put a foreigner over thee, who is not thy brother. Only he shall not multiply horses to himself, nor cause the people to return to

> Egypt, to the end that he should multiply horses; forasmuch as the Lord hath said unto you: "Ye shall henceforth return no more that way." Neither shall he multiply wives to himself, that his heart turn not away; neither shall he greatly multiply to himself silver and gold. And it shall be, when he sitteth upon the throne of his kingdom, that he shall write him a copy of this law in a book, out of that which is before the priests the Levites. And it shall be with him, and he shall read therein all the days of his life; that he may learn to fear the Lord his God, to keep all the words of this law and these statutes, to do them; that his heart be not lifted up above his brethren, and that he turn not aside from the commandment, to the right hand, or to the left; to the end that he may prolong his days and his kingdom, he, and his children, in the midst of Israel. (Deuteronomy 17:14-20)

A system of values opposite to the Jewish mind-set could be based on two extremes: the subordination of man to the forces governing him (be it God, a leader, or both) or the superiority of man over the forces of the universe. Most religions and ideologies profess the first kind of attitude; in fact, I know of no other religion which claims any kind of equality between man and God. A system of values proclaiming man's superiority over the forces of nature corresponds to the communist ideology in its pure form. However, the actual implementation of communist ideals is oftentimes accompanied by instituting an authoritarian regime prone to the dangers of transmuting into an ideology directed at subjugating man to the forces governing him, that is, an ideology that is fundamentally alien to many Jews.

Interestingly, these attributes of the Jewish mentality are particularly bothersome to the intellectuals. There exist certain spheres of society which, if penetrated by foreign bodies with a radically different system of values, would pose a grave danger stemming from the fact that these foreigners would be in a position to alter the system of values of the country as a whole (of its major ethnic group), steering it astray from its indigenous or true course. To clarify my point, I want to distinguish the sphere of programming, which includes ideology, art, basic science, mass media, education, politics, military, economic leadership, etc.—all the spheres involved in defining society's genetic code. The infiltration of the Jews into the programming sphere is considered most ruinous to the development of the native ethnos, for the Jewish system of values may disturb its genetic code.

All these deliberations suggest that the Jews will, for various reasons, be incompatible with a great number of peoples. One well-known solution to preserving the Jews as an ethnic group is to have both a Jewish state and Jewish Diaspora in countries that are more or less compatible with the Jews.

MEASURING PREDISPOSITION IN A SOCIAL SYSTEM

We are now in a position to make some generalizations regarding the category of predisposition as it pertains to social systems (the same category is also discussed in a separate chapter on indeterminism in the economic system).

How does one go about (co)measuring the various social indicators? The key issue is supplementing (either explicitly or implicitly) initial parameters (both essentials and positional) with conjugate (dual) ones (i.e., the valuations). Ackoff (1994) distinguishes between *efficiency* and *effectiveness* (pp. 50-51). Efficient development entails change in initial parameters, while effective development entails higher valuation of these parameters.

Methods of measuring effective development may not be amenable to formalization because of the inherent duality of the problem: it may be analyzed from two different perspectives: *horizontal* and *vertical*. I refer the reader to my work (1992*b*) which explores the two approaches in another context and under highly simplified assumptions.

The horizontal method is predicated upon the two following conditions: (1) the system includes a multitude of agents each of whom is capable of measuring his own level of predisposition; (2) the system specifies rules of interaction, which all agents must follow. These rules may be derived via a democratic mechanism (for instance, the taxation policy for the redistribution of income); there are institutions which make sure that all the participants conform to the rules of interaction. The resulting actions of the participants indicates the system's predisposition toward development. Pareto optimality principle (predisposition is manifest by the utility function) can be interpreted as one such horizontal mechanism for measuring the systems' predisposition toward development. The actual value of the function need not be calculated precisely. It can be inferred by observing the extent of people's discontent with the current state of affairs, manifest in such phenomena as strikes, demonstrations, uprisings, voting trends, etc.[31] The actual quantification of this indicator yields a subjective assessment, since the entire procedure is based on subjective valuations (revealed by the polls, surveys, etc.).

Kenneth Land (1975) presents an in-depth analysis of quantifying predisposition using a vertical method. Moreover, the procedure is formalized: it either designates a weight function based on initial and conjugate parameters, which capture the notion of predisposition, and the value of this function indicates the system's predisposition toward development; or it formulates goal(s) and then assesses the extent to which the current state of the system contributes to the set goal(s) and respective priorities (see *United States. President's Commission...,* 1961.) As Gerard Debreu (1959) pointed out (albeit with respect to economic systems), under certain rather plausible conditions, the vertical and the horizontal methods of searching for the value of predisposition toward social development are each reducable to another.

Any technique used to evaluate the predisposition of a given societal system toward development is invariably informed by the values espoused by the leading institutions, which guide the system. In the case of an authoritarian regime (the simplest case) these values descend from the leader. Naturally, in keeping with his goals, the leader strives to reduce the problem of development

to that of growth. Even if the leader recognizes that "the time out of joint" his assessment of development will bear the stamp of his objectives. This point is valid in time and in space: the latter is manifest in the leader's assessment of the systems of other countries, insofar as these countries affect his own plans. The resulting assessment may be quite sophisticated if it incorporates reflexivity in each country's perception of the other.

In a democracy, the assessment of societal development depends on the perspective of the various parties partaking in the political process (ultimately manifest in each party's political platform). The subjectivity in assessing the country's dynamics is further confounded by the fact that the party's platform is modified by the party's leader who wants to be elected to office.

The ultimate result of all these programs, as filtered through the country's political mechanism (notably, the parliament), is reflected in a formal statement, typical of the vertical mechanism of assessment, which defines the valuation of the current state of the society. If made by an independent council, this assessment may sidestep the political biases, but not the subjective vision of the expert. Perhaps, if the expert is aloof to the political passions of the time, his assessment will encompass a broader database which reflects the country's historical traditions rather than the current political strife and economic fluctuations.

It is probably impossible to eliminate the subjectivity of the agent doing the assessment, if only because there is no programmatic bridge between temporal discontinuities in the indeterministic fabric of the world. Moreover, the subjective valuation of development based on the weight function lacks precision because the person doing the assessment lacks explicit knowledge of the weights of positional parameters as well as the relevance of those which he does take into account. In short, horizontal and vertical methods of measuring predisposition engender both objective and subjective indicators.

In summary, with respect to societal systems, my approach to indeterminism would seem to imply that from a global perspective a societal system is deterministic: the impossibility of choosing a proper direction of development is inevitable. At the same time in terms of the already selected direction of development), a societal system is indeterministic. In other words, the evolution of a societal system in any direction represents a protracted process, comprised of various phases that are characterized by varying degrees of indeterminism.[32]

The present chapter spotlight the stage of creation of predisposition. This stage features various essential and positional parameters. The former are, in turn, divided into structural and characteristic parameters. I shall focus on the characteristic positional parameters, since the structural ones are amply illustrated in the literature on the subject of social indicators. The latter include human rights (illustrated by the dissident movement in the former Soviet Union, diversity and of ethnic groups and their compatibility, etc.).

Predisposition toward development can be measured vertically or horizontally. Democratic systems typically embrace the horizontal mode, epitomized by the discontent expressed by the population. Authoritarian systems gravitate toward a vertical method of assessing a predisposition in the frame of a style which is intrinsically goal oriented and seeks to objectivize the results.

NOTES

1. Russell Ackoff's book is similar in scope to the range of social issues explored in the present work. As the title suggests, Ackoff's book zeroes in on *redesigning the future* and linking it to the present.

Designing the future requires knowledge of the past (since societal process is non-markovian). This raises the problem of elaborating a methodology for *redesigning the past* and bridging it with the present. However, these two tasks are confounded both by our ignorance of many facts from the past as well as the overabundance of facts about the past. As a result, similarly to the link between the present and the future, the link between the past and the present is also subject to "time out of joint."

2. "When your croquet ball mysteriously veers to one side, you can always look for pebbles in the grass. But when your Bishop is deflected, you cannot search for imperfections in the playing surface. In chess everything is open"(p. 130).

3. Just like animals but with superior ingenuity, people make decisions which involve coercion, lie, misrepresentation, etc. To a varying extent, people seek to increase and capitalize on their prestige, oftentimes resorting to immoral means to get rid of their adversaries. As people age and lose their strength, they still wish to maintain their status. They may try to create a false impression about the power they hold, or try to get rid of anyone competing for their position, especially if the competition devises new pieces and rules with which the existing pieces do not know how to interact or unable to interact due to the irreversibility of the aging process.

From this perspective, wars represent an integral part of human conduct. Not only do wars resort to coercion to resolve conflicts, but they also frequently violate the rules. Take guerillas warfare, for instance. Since the guerillas operate on the home front, their actions necessarily entangle the civilian population. The occupying army, even if it does not wish to involve the civilians, must take cruel measures against the civilians to counter and discourage guerillas raids. I am not sure whether or not it is true, but during World War II the German leadership appealed to the Soviet leadership to abort guerrilla tactics in the areas occupied by the Germans. Whatever the intentions of the Germans, it would be an act of good will (toward its own population) on the part of the Soviet leaders to terminate guerrilla warfare in the occupied territories. Still, the Soviet leadership refused. The majority of the people did not condemn the leadership for this attitude toward its own civilian population. Denunciation came from a small group of intellectuals, notably in the writings of a Belorussian writer Vassily Byckov. Interestingly enough, the far from humane German leadership did not employ guerrilla tactics in the areas occupied by Russian or Western forces, even while the war was still waged on German soil, not to speak of after the capitulation.

4. Under a vertical mechanism the center typically concentrates all efforts upon the attainment of the set goal (it is not an accident that during major wars vertical mechanisms also come to the fore in countries otherwise governed by horizontal market-type mechanisms). Participants of the vertical mechanism are committed to fulfilling the assignments issued by the center. Horizontal mechanisms arise in situations lacking well-defined goals and featuring autonomous actions of interacting participants.

Horizontal and vertical mechanisms feature many subvarieties. In real life, the social systems are not based on pure or any one mechanism, but they do feature a dominant and a subordinate one.

5. By analogy with biology, in physics the idea of development applies to the evolution of the stars as well to the Big Bang.

6. Translated into English by Thomas Bradley.

7. Gorbachev's policy resembles that of the last Russian czar Nicholas II. Russia's

defeat in the Russo-Japanese War in conjunction with the 1905 Revolution compelled the Czar to acquiesce to a constitution, a multiparty system, Duma, etc. Still, Nicholas maintained his supreme authority and the Russian empire. History has proved this flexible policy to be highly unstable. During the very first major crisis the czarist regime was toppled, and in February 1917 a destructive democracy, characterized by ochlocracy and anarchy, was instituted. This "democracy" endured for close to eight months until it was finally swept away by the Bolsheviks, reverting Russia back to an authoritarian and imperial regime. In the general scheme of Russian history, the Bolshevik October Revolution is actually a counter revolution. The true revolution took place in February, when an attempt was made to break with Russia's authoritarian-empirial ways.

8. The work by Russell Ackoff and Fred Emery (1980) gives a two-dimensional classification of extrovert and introvert ideologies. This classification is based upon an analysis of "the personality of an individual in terms of the two relations that can exist between him and his environment: (1) the extent to which his environment affects him (environmental responsiveness); and (2) the extent to which he affects his environment (environmental affectation)" (p. 117).

From the standpoint of an individual's response to his environment, the authors distinguish between an *objectivert* (a man responsive to his environment), and a *subjectivert* (one who is not responsive to his environment). From the standpoint of an individual affecting his environment, the authors distinguish an *externalizer* (a man who is inclined to change his environment in accordance with his needs), and an *internalizer* (one who, by changing his internal world, adapts himself to the environment). On the basis of classifying personalities in these two terms, (i.e., individual response to the environment and individual affecting the environment), four personality types were synthesize.

9. An in-depth analysis of Ackoff's concept is given in my article (1992*a*).

10. A somewhat simplified planning scheme composed of a *two-step* process was outlined by Peter Lorange (1980). The first stage formulates an *objective* and the second a *goal*. "Objectives...are more general statements about a direction in which the firm intends to go, without stating specific targets to be reached at particular points in time. A goal, on the other hand, is much more specific, indicating where one intends to be at a given point in time" (p. 38).

11. Just to reiterate, the comprehensive method with its proclivity for the program-like method does not preclude the creation of predisposition, which serves the ultimate goal. Let us go back to our examples with Russia. The idea of Russia being the third Rome, and a fourth there will not be, is deeply entrenched in the Russian ideology. Soon after the communists came to power, lead by Lenin, this idea began to gel, and in 1924 Stalin rehashed it under the banner of *victory of socialism in one country*. Translated into the common vernacular, this highbrow slogan reads: "Two Romes have fallen, but the third stands, and a fourth there will not be." This program was opposed by the concept of a *permanent revolution*, which proclaimed that if the cause of world revolution calls for Russia to burn in the bonfire, so be it. Stalin created the most powerful empire in Russian history. It made the world tremble and it seems to embody the centuries-old Russian dream. It would seem that the Russian nationalists would applaud the Bolshevik revolution which eventually propelled Russia to the status of a superpower. They would also have to bless the Jews, who played a prominent role in the revolution and in forging the military might of Stalinist Russia. Nonetheless, for the most part Russian nationalists loath the role of the Jews in forging the great Russia. The nationalists are not overly concerned with the essentials, such as Russia's incredible industrial power and the demise of millions of people who died in the process, but they are anxious about the excessive role of the Jews in destroying the traditional positional parameters of the Russian culture,

manifest in orthodox faith, the holy private property, emphasis on spiritual life. They detest, among other things, the imposition of Western values that are allegedly foreign to the Russian mentality. The nationalists claim that all these abuses have detracted from Russia's predisposition to follow its indigenous path.

12. The collapse of the communist ideology in U.S.S.R. and Eastern Europe and subsequent disclosure of its inhumanity does not mean that the communist ideology is dead. Just like millions of people throughout the ages believe in paradise in heaven or in nirvana, there will be people who believe in the possibility of creating a paradise on earth. This is were Marxism comes to the fore. It promises to fashion paradise on earth based on scientific methods rather than miracles. The rapid progress in science and technology may actually foster this ideology. And no experiment gone sour will deter the proponents of this doctrine from trying again and again. They will attribute the failure of the countries that tried and failed to a lack of honest leaders and other incidental circumstances.

13. In the U.S.S.R. it was thrice proclaimed that the current generation of Soviet people will l see communism. Actual programs were devised to this end; similar declarations was made in China at the end of the 1950s. Perhaps, these claims are rooted in the age of the leaders who were still young enough to believe that they will live to see the day their dream will become reality. Lenin, Stalin, Khrushev, Mao Tse-tung were all under the age of 70 at the time they announced their bold program of building commnism.

It is also important for the eschatological ideology to instill hope in its followers, to assert that at least those who are young or middle age (who actually make up the bulk of the proponents of the new ideology) will live to see the realization of their dream.

14. An article by Thomas Friedman (1989) corroborates my observations. Friedman writes: "United States policy is always going to be focused 'more on two years down the road, not 10,' explained a State Department official. 'The Soviet game is chess, where you think out your strategy 10 moves ahead, and Gorbachev is a chess player. Our game is baseball. You play it one inning at a time, but its the final score that counts. Gorbachev may hit an occasional grand slam. We are going to try to win on singles.'"

15. Quoted in Albert Schweitzer (1948).

16. I agree with Ackoff (1994) that *quality of life* pertains to development, while the *standard of living* reflects growth (pp. 46-47). Using my terminology, quality of life measures predisposition, while the *standard of living* is related to a combinational style characterized by program-like deterministic approach.

17. The set of indicators that defines the system's predisposition toward development ought to incorporate temporal as well as spatial variables (i.e., the in space interrelations between a given system and other systems). Presumably, the optimum set-up is when the development of a given system benefits other systems with which it interacts, creating a win-win situation.

18 . Quoted in Jamshid Gharajedaghi (1985).

19. This kind of competition is more prominent in horizontal mechanisms, but it does take place in vertical ones as well. In the latter, if the supply exceeds the demand the surplus assume the form of *reserves* of resources. In essence, these reserves represent expenditures on creating special incentives for improving labor productivity.

20. It would be too trivial to portray different kinds of competition observed in different social systems as opposites. Stalin (1949) maintained that under socialism, workers engaged in socialist competition cooperate, while capitalist-type competition, based on the principles of "*defeat and agony for some and triumph for others*" and "*finish off those lagging behind in order to assert your superiority*," is ridden with conflict and

strife.

21. The brilliant work by a prominent anarchist Petr Kropotkin (1904) presents some profound ideas on the diversity of relationships among the living creatures at the various steps of the evolutionary ladder. I would venture to make one generalization: Cooperation is more pronounced in situations where a joint effort can *lift the constraints* imposed upon the group; conflict is representative of situations where the animals strive to survive subject to *insurmountable fixed constraints*. For example, during periods of droughts wild horses may congregate into herds numbering tens of thousands of animals and together the herd seeks new feeding grounds. Herbivores that are vulnerable to predator attack and, individually, are limited in their ability to defend themselves, may flock into groups in order to improve their defenses. On the other hand, when put in a pen and given a limited amount of feed, wild horses will start to struggle with each other for food—a classic case of survival of the fittest. Kropotkin extends this frame of reference beyond the animal world to the world of human relations.

Just to reiterate, cooperation tends to predominate if it allows certain constraints to be lifted. In case the constraints cannot be lifted within a foreseeable future (defined by survival) conflict becomes the principal mode of interaction.

22. *Love* can be recognized as a certain kind of cooperation and defined as *mutual attractiveness via beauty*.

23. This notion of how a culture is shaped is questionable; it reflects the rather conservative vision of the social process with emphasis placed on long-term factors which promulgate the differences among the various groups of people (including biological differences). The liberal agenda emphasizes features shared by all of humanity and attributes cultural differences to historical factors that define the social context for a given group; these factors are amenable to change within a relatively short period of time. In the last few years, works have appeared that attempt to link one's ethnic background with a propensity for a particular type of behavior. One example is the work by Taylor Cox, Sharon Lobel, Poppy McLeod (1991). The abstract to the article reads:

> Empirical evidence is found that ethnic group differences affect at least some aspects of behavior in task groups. In the study, student subjects were assigned to ethnically diverse or all-Anglo groups, and a Prisoner's Dilemma task was used in which participants could choose to compete or cooperate with another party. It is found that at an individual level, Asian, black, and Hispanic individuals have a more collectivist-cooperative orientation to a task than do Anglo individuals. The analysis also finds that the knowledge of this individual-level difference can be drawn on to predict differences in group behavior on a group decision-making task. Behavioral differences tend to increase when the situational cues favor cooperation. Since the work force will increasingly be composed of members of non-Anglo groups in the future, the behavioral differences that were found may have a significant impact on how work is done in organizations.

24. While they share some ideas, the work of each ideologist of the dissident movement focuses on some particular facet of society. Valery Chalidze (1984) spotlights socio/human rights issues; Andrei Sakharov (1975) focuses on sociopolitical issues; Boris Shragin (1978) on philosophical issues; Valentin Turchin (1981) exhibits a natural scientific bent.

25. More on this in my book (1990).

26. See my work (1989*a*).

27. This distinction between strategic and tactical decisions is very vivid in social life. So-called practitioners are people who are finding one best trick, the best way to solve problems in the frame of the given constraints; the latter is impossible to remove in a short period of time. The so-called theoreticians are first of all oriented to remove the constraints and this requires a long time. Such a distinction between theoreticians and practitioners is a false one. Both of them eventually have to implement their ideas into real life—the difference between them concerns only time. That is why is so popular the saying "There is nothing more practical than a good theory."

28. In my 1992*b* book (pp. 63-64) I examine the various types of pluralistic mechanisms from the standpoint of the underlying methods of operation (the method of potentiating and programming method). I argued that a pluralistic mechanism based on faith and operating at the top levels of the ideological hierarchy may be viable within a given country (in a sense that no one will be coerced into a repugnant ideology). Actually, as it stands, this statement must be qualified by stipulating that the groups adhering to non-reigning ideologies must not be too numerous.

Here I also want to use the opportunity to clarify slightly the differences between relativism and pluralism. *Relativism* assumes that every person has his/her own *truth*; *pluralism* assumes that every person has *hypothesises* concerning different topics. That is why in the case of relativism people are usually predisposed to be *closed* to other opinions and to *fight* on the name of absolute truth; in the case of pluralism people are usually predisposed to be *open* to other opinions, that is, to a *dialog*.

To recognize the difference between relativism and pluralism is very essential for understanding the development of a society. It is more difficult to keep a manifold if the culture of people is based on relativism. Certainly, if people are being convinced of knowing the absolute truth they in extreme situations can even pursue with great fanaticism the imposition of this truth on other people on the name to help them to achieve happiness. In the case of relativism the preservation of a societal manifold requires very strong social institutions that don't allow one group to impose their truth on other groups, that is, to replace the manifold by a singular variety. In the case of pluralism people are more tolerant because they do accept that they have only a hypothesis. Even this hypothesis is prioritized by a given person, the holder of it knows that it is only a hypothesis that has to be further developed. Under such conditions is much easier to develop a societal manifold and combine it with a variety.

29. The great feat of the heart transplant operation is finding the *necessary* conditions qualifying a heart to be a donor's heart. Still, these indicators are insufficient for total compatibility between the recipient and the donor's heart. Let me propose a very crude blueprint for making up for this deficiency. First of all, the discovered indicators represent essentials (material parameters). Perhaps, they are found lacking because other essentials are required for total compatibility. However, assuming these essentials are hard to uncover, we can, under certain conditions, assess the hearts' predisposition toward compatibility (for instance, when the known indicators suggest that the transplanted donor heart will perform well but might still be rejected by the patient). In these cases, we ought to supplement essential parameters by the positional ones that reflect the hearts' compatibility. Presumably, certain relationships among the essentials parameters will make up for the information gap in these parameters. As we assign weights to essential and positional parameters that characterize the heart (ultimately, the weights must reflect the functions fulfilled by the heart), we arrive at the overall evaluation of an individual heart. Evaluations that are far apart may suggest that the hearts are incompatible.

30. This part is based on my works on the subject of anti-Semitism. A reader will

find a brief summary of these works in chapter 8 of my book (1990).

31. Naturally, this applies to democratic systems. In totalitarian systems, it is more difficult to uncover the indicators reflecting the discontent of the population with society's course of development.

32. The development of a society, an organization, or an individual resembles the history of chess styles. Let me illustrate this statement with several examples.

The combinational style in the social realm may be observed in the idea of promotion based completely upon one's merit (material parameters). The affirmative action represents a positional style involving a positional sacrifice. This program also considers such complex positional parameter as the amalgamation of the various strata and the diversity of people within each stratum each of them, with particular emphasis on the middle class and the presence of minority groups in the middle class. A number of people oppose affirmative action arguing that the positional sacrifice inherent in this program is unfair because it tends to waste the material resources and corrupt the minorities. The proponents of affirmative action regard this program as means of making the society more harmonious and less violent. They also claim the failure of this program is the result of its implementation by the country's leaders who are not "grandmasters". I would only say the program is not bad per ce and one should not confuse faulty implementation with the validity of the program under proper circumstances. Thus, the solution of the problem is not to revert to the combinational style but to uncover the conditions under which the positional style is adequate.

At the level of an organization, the positional style is illustrated by the university admission policy. Beside the applicant’s merit the universities take into account the diversity of the student body, as this is supposed to benefit the students by acquainting them with a variety of cultures. Many people reject this kind of positional sacrifice claiming that the admission policy ought to be based on merit only. The validity of this policy can be judged in the same way as in the last case.

The last example concerns the positional style at the level of an individual. My former student Matthew Mandelbaum wrote in his course paper that when he visited his parents he decided to sacrifice his preparation for the upcoming tests in favor of visiting a football game with his father in the name of improving their relationship.

4

ETHICS

The introduction and the previous chapters formed the foundation of my general systems approach to values in an indeterministic environment. In this chapter I will investigate how this may be applied to social values in all realms of human behavior. Values that arise in this realm (apart from the purely economic ones) constitute the domain of moral-ethical values. These values will be investigated without reference to their social origins: I am not concerned with whether these values are religious or mandated by civil authorities (as was the "Moral Code for a Builder of Communism" in the former U.S.S.R.). Whether they are decreed from above (vertical) or emerge in a process of local interactions (horizontal) and then become established as tradition (much as the market determines prices) will not be addressed. I will, however, be concerned with the part played by biological and social factors in the origin of moral-ethical values.

WAY OF LIFE AND ITS STRUCTURE

Toward a Conception of Morality, Pragmatic Values and Ethics

The combined judgments which give shape to people's values and interpersonal relations (as well as relations between people and the nature) may be termed *way of life*.[1] This introduces the moral-ethical problematic. The broad meaning of way of life is especially important since I intend to dissect the concepts of *ethics* and *morality*. Literature usually makes no clear distinction between the two concepts. Essentially, these terms are viewed as synonymous. Etymologically, *ethics* is derived from *ethos*, Greek for "character." *Morality* comes from the Latin *morales*—"custom." These terms emphasize different aspects of human behavior, and even specific acts. Literature does delineate the concept of *Metaethics*, which focuses on the nature of moral concepts and judgments, but this notion is introduced without making a real distinction between moral and ethical conceptions.

I agree with those who believe that a fairly clear distinction between these two concepts may be made. This is best done through the most diverse possible classification of values: according to globality, conditionality, etc.

For example, Russell Ackoff (1994) writes "of ethics as dealing with principles that are transsocietal, and are intended to apply to everyone, regardless of what society they are a part of; and morality as principles are generated by a society and may apply only to it" (pp. 52-53).

Ackoff uses the criterion of globality to distinguish ethics from morality. Such a conception of ethics does not seem adequate. As Ackoff himself concedes in the same book "What is good in one society may not be in another. This is consistent with anthropological findings that there is not a single ethical principle that is universally adhered to—that is, in all societies" (p. 55).

I propose other criteria to differentiate between morality and ethics. Social values are first classified in a spectrum according to their *degree of conditionality*.[2] The two extremes (and the values that tend toward each, as will become clear in the detailed analysis of the spectrum of values which follows) I will term: *moral values* for unconditional values and *pragmatic* (or *instrumental*) *values*—for conditional ones. These concepts will be qualified further.

With this in mind, *ethics* refers to a metaconception that encompasses the numerous factors on which morality and pragmatic values are based. It also integrates values of varying degrees of conditionality employed in diverse situations. For instance, an ethical principle might stress what one should not do (negative morality), such as "do not do unto others as you would not have others do unto you" (according to the notable Jewish thinker Hillel (60? B.C.–10? A.D.), this is characteristic of Judaism). Another ethical principle might stress how one should act: "Do unto others as you would have them do unto you." To some extent this is characteristic of Christianity, which places great emphasis on positive morality.

The concept of justice as a valuation of human relations clearly indicates the importance of ethics. For example, how might the last bit of water be divided between two people wandering in the desert?

1. The stronger takes it
2. It is given to the weaker
3. A coin-toss
4. It is divided equally
5. The water is poured out that both might perish with pure souls.

Ethics plays an important part in establishing legal norms and relating them to morality. For example, in the case of punishment, what should guide a legislator? What should a guilty party receive in return for his act? There are a number of options: (a) isolate the guilty party from society, in extreme cases employing the death penalty; (b) make the guilty party compensate for any damage; (c) deter the criminal from breaking the law in the future; (d) discourage other people from breaking the law.[3]

Because it is rather difficult to pinpoint the role of each of the above-mentioned ethical principles and, moreover, to unite them, a metaethic is required. This ethics hierarchy (ethics, metaethics, etc.) may be developed further. However, if the universe is assumed to be indeterministic, then it is impossible to find a level at which one could formulate an absolute ethical principle leading to an optimal spectrum of values.

Modes of Representation of Social Values

Social values may be variously represented as either a valuation of the *components of the state of the men* influencing human interrelations or as a valuation of *acts* whereby one component is transformed into another. In presenting a valuation of the components of the state of the men one introduces a weight function. Initial parameters which characterize the individual serve as a point of departure. Each parameter has a certain degree. These initial parameters are correspondingly valuated. In a linear approximation the sum of these valuations brings an evaluation of the position of the individual as a whole. As in chess, a new evaluation results when the condition is altered by a move. This evaluation takes into account the move of the given individual (including changes in his inner-vision) and the reaction of the opponent. We speak of the new condition in terms of the value resulting from the difference between these moves.

Such a general approach to the measure of change in the state of an individual can become rather unwieldy when dealing with isolated acts. The last ones can be treated in an abstract way as independent processes of transformation of a component from one state into another. On each state each component is correspondingly evaluated and the difference between these valuations is resulting in the total value of the act. In this case, if an isolated act is evaluated positively, it may then be reinforced by a dictum to act thus. If the given act brings negative results, it may be prohibited. This is reflected in morality as it was defined above (for example, thou shalt not murder, thou shalt not steal).

If changes in behavior were limited to meeting these kinds of demands, then, all other variables being equal, they could be codified. Taking this to a hypothetical extreme, they would occur automatically. In living organisms such a conception of action could have been expressed through reflexes. But a person can often fail to do what is demanded of him, even when it is reinforced by a reflex. He possesses free will (the Bible notes this in relation to Adam and Eve breaking God's command and eating from the Tree of Knowledge). Therefore, the forbidden act acquires a definite value, and a person must assess the advisability of disregarding the injunction. I will look below at this evaluation.

A TYPOLOGY OF VALUES

The Globalization of Valuations

For the purposes of this investigation, I will first construct a simple typology based on two types of parameters: the degree of globalization and how directly the origin of valuations relates to the outer world. In simplified fashion,

the first parameter may be divided into a local and a global characterization of values. The first is that of the local object. The second is inherent to the societal field in which this local object is immersed. This is only a rough division, since the fields in which a given object is immersed form a hierarchy.

The second parameter may also be divided into two groups. Internal (endogenous) valuations are inherent to the given subject. External (exogenous) valuations are inherent to the societal field.

Morality and the *law* are examples of exogenous global valuations of behavior. Examples of exogenous local valuations of behavior are provided by all sorts of *restrictions* placed on the behavior of a given subject, for example, restrictions placed by parents on the behavior of a child.

Endogenous local valuations are exemplified by the *subjective utility* assigned to various goods or acts. *Conscience* is an example of an endogenous global valuation.

These different kinds of valuations are interrelated. That these relations be understood, at least one more classification of values, with regard to the degree of their conditionality, needs to be introduced. But first I would like to return to the classification of values described above. In it, we find conscience. I would like to examine the nature of this rather poorly studied category, and show how it interacts with the other categories of the given classification.

By conscience, I mean endogenous global values, an internal morality possessed by the individual. This is reflected in language.[4] The Latin *conscientia* is composed of two parts: *con*, communality; and *scientia,* knowledge emanating from the environment. The same is true of English, *con-science*, French, *conscience*, German, *Ge-wissen*, Greek, *sun-esiz* (sünesis), and Russian, *so-vest* (sovest'). It would be interesting to examine the etymology of this word in other languages.

Apparently, developed biological organisms, and especially people, are distinguished by an informational contour, in which both local and global endogenous values are reflected. Such combinations of values are reflected in investigations done by ethicists, for example, Konrad Lorenz (1966). When a carnivore displays aggression, a local endogenous value, it possesses an internal restriction that forbids it from killing others of its own kind. This is a global endogenous value. One could even suppose that conscience is expressed physiologically. For example, the revulsion at killing one's own kind might be triggered by the smell or sight of their blood. Conscience enables a biological individual to act autonomously and still possess its link to the whole.

This also applies to human society, albeit with some significant modifications. The theory that appeared during the Renaissance, according to which man is a *microcosm*, is indeed a manifestation of the fact that the universe is reflected in the individual. This theory is the basis of the recognition of personality. The conception of conscience is an expression of the fact that awareness of other people's feelings is reflected in the individual's self-awareness.

Indeed, a person may, under certain conditions, make the best possible choices by using global and local endogenous values and, without recourse to the exogenous system of values, consider the interests of other members of

society. A similar situation may be found in the market. When an individual interacts successfully, he decides what is best to produce (this includes his labor) and consume by following the market price (a global exogenous parameter) in addition to his subjective utilities (local endogenous values). And if prices are so stable that each individual becomes accustomed to them, it is as if they are transformed into the parameter of global endogenous values.

It stands to reason that in speaking of conscience as a global system of values that is endogenously inplemented in the individual, one must consider that it need not be *unified*, in the sense that each subject shares the same conscience. Systems of inner morality, just as systems of outer morality, may differ. All the same, it is assumed that conscience serves to meet certain demands advanced by the majority.

The values discussed above are *differential* values, in that they relate to discrete objects (acts). There also exist *integral* values. They are a scalar product of the vectors of initial social parameters and corresponding differential valuations. Prestige in social life and money in economics, present examples of integral values. The ability to vary, and carry either a negative or positive sign is a general characteristic of these integral values. They serve as universal constraints. Needed goods may be obtained within their bounds. They may become devalued with time, and so forth. At the same time, each of these integral values has its own particular characteristics. For example, if money is shrinking as soon as it is spent to obtain goods, prestige is usually not affected.

A Spectrum of Values According to Conditionality

In the chapter on chess I spoke at length about constructing a spectrum of values in terms of their conditionality. It is best that the reader familiarize himself with the approach used in constructing such a spectrum prior to reading the following section.

This spectrum may be divided into the extreme groups of *fully conditional* and *fully unconditional* values.

Fully conditional values depend on a combination of four preconditions: (1) driving forces, (2) some initial resources, (3) rules of interaction that allow resources to be transformed into a final result, and (4) a procedure capable of fully integrating the former three preconditions in a noncontradictory way.

It stands to reason that *fully unconditional values* are formed when even the third and/or the fourth of these preconditions are lacking.

Let us start the analysis of social values from the diversity of the valuations of essentials. In a society, people are the essentials. By this, I mean people in all of their aspects, and not merely as workers. These are the valuations that I would like to discuss here.

The assertion that a valuation of any single individual's life is indistinguishable expresses a fully unconditional value. This is indeed seen in certain tribes of New Guinea, where murder is considered insignificant. The spirit remains, and the members of the tribe may communicate with it during nightly visits. When society evaluates human life in a particular way (for instance, when for

committing certain acts under certain conditions, a person is condemned to death), we are dealing with fully conditional values.

Between these two extremes of fully conditional and fully unconditional values, we also find intermediate stages of conditional, semiunconditional and unconditional values. Each stage is determined by which premises (or a part of a premise) are selected from among those required for the formation of fully conditional/ unconditional values.

One may suppose that the degree of conditionality of the values employed depends largely on the proximity of a goal, if such a goal exists. For human society, development lacks even a clear direction. Even when a direction is chosen, a great diversity of situations arise. Thus, the whole spectrum of values will be applied. If we admit that we do not know the true direction for the development of mankind (one such course of development might entail humanity's disappearance, so it is not even possible to prove that human society should exist) than human values become fully unconditional. In that case, in respect to people, anything is permissible.[5]

However, all known civilizations have taken the necessity of human society as axiomatic. This was justified by the inherent will to live (the difficulty of suicide) and by propagation of the human race. Thus, people's valuations are modified somewhat and belong to the positive octant; they become unconditiona*l* (i.e., they have a positive or negative sign). The life of each individual becomes invaluable. This means that, despite our inability to say anything definite about the specific value of an individual person, we can say that each one is valuable. It follows that, operationally, there is a leveling in respect to people's value. Thus, people strive toward an ideal of unconditional valuations, concentrated in the positive octant, rather than toward fully unconditional valuations. This gives rise to social doctrines that suppose that it is not admissible to improve conditions for some people at the cost of making them worse for even one person (i.e., the condition of Pareto-optimality). Even if these doctrines are not put into practice, their influence is felt in the idea that each person is equal before the law.

There are serious practical difficulties in applying the idea that all people are of an equal value. Not all people are equally productive, and society has limited resources. Under these conditions, the differentiation of people according to their importance begins as soon as the question of distributing resources arises. This differentiation can be done under various degrees of completeness of conditions. If the conditions involve only rules of interaction between people, one deals with semiunconditional values. As an example of this type of values can be used the attempt to evaluate soldiers, officers and generals based on their ability to act in the realm of the established rules of interaction independently from the boarding conditions and the algorithms of the military performance.

If one adds to the semiunconditional valuation of a human being as an essential, some semiunconditional valuations of surrounding him/her positional parameters the result will be expressed in a conditional value of a human being, that is, in a positional price. Such prices are not yet developed. Their develop-

ment is important for the measurement of the value of a human being in the process of elaboration of a goal of a combination under indeterminism.

Under particular circumstances a semiconditional valuation is introduced in respect to the value of human life (see Jeffrey Williamson, 1984). It is employed by insurance companies, engineers when they are evaluating the dangerous aspects of new technologies, etc.[6] A particular war situation can serve as an example of fully conditional values of a certain human being: an officer has to make a decision by whose life he is sacrificing to achieve the goal.

Integrating the whole spectrum of human values presents a task of incredible difficulty. What follow are only some thoughts on this problem.

Considering what has been said about the classification of values (meanwhile, differential and integral values are not considered; the spectrum of values is represented by its two extreme poles), the valuations employed by a person in determining his behavior may be represented by the Figure 4.1.

Duration of Social Values

Another important aspect in the classification of social values relates to duration. The duration of reward-punishment (*r-p*) used to enforce moral and pragmatic values is one of the parameters determining its force. The *r-p* might extend over a brief period of time, a person's whole life or a significant portion of it. It might be thought to persist even after his death. Factors determining *r-p* duration within a person's life span are sufficiently clear. One may suppose that extending *r-p* beyond death is an attempt to further stimulate people to follow moral-legal regulations. The particular methods employed vary between different cultures.

In a culture that believes that the body and soul are distinct entities and that a soul leaves the body to enter the afterlife, a future *r-p* can be administered through such institutions as hell/heaven, reincarnation or nirvana.

The concepts of soul and afterlife do not exist in Judaism as it is presented in the Torah. *R-p* of an individual is carried out via future generations. This is evident in the *r-p* proclaimed in God's name, "visiting the iniquity of the fathers upon the children unto the third and fourth generation of them that hate Me; and showing mercy unto the thousandth generation of them that love Me and keep My commandments" (Exodus, 20:5-6). Similar pronouncements, with slight modifications, also given in the name of God, found in Deuteronomy, 5:9-10.

It appears to me that the system of *r-p* after death presented by the Torah was inspired primarily by the need to increase a person's motivation to follow existing moral regulations.

Figure 4.1
Valuations of Human Behavior

Source of the Value	"Scope" of the Value	Degree of Value's Conditionality	
		Conditional	Unconditional

Endogenous	Global	"Prices"*	Conscience
	Local	Extreme Usefulness	Usefulness Function
Exogenous	Global	Law	Morality
	Local	Limitations on a Given Individual	Customs of Small Group

* A hypothesis regarding the possible ways to integrate feelings is dicussed in Notes, 13.

The phenomenon may also be explained in other ways. For example, Jeffrey Tigay (1996), supporting his views with corresponding citation, considers: "This view of divine retribution as extending to descendants corresponds to the concept of family solidarity that was felt strongly in ancient societies, especially those with a tribal background. This view was progressively modified in the Bible in the direction of the principle that individuals should be rewarded and punished only for their own deeds" (p. 66).

There is a solid basis for this point of view. Many ancient peoples living in that region, Persians and Macedonians among them, would execute a criminal's family along with him. In recent history, a similar position was taken toward those declared state criminals under totalitarian regimes, most notably in the U.S.S.R. under Stalin. Such vengeance against the family of a state criminal apparently was also dictated by a fear that the relatives might seek vengeance for the death of a family member, whom the relatives consider innocent.

For this reason, the responsibility of future generations for the acts of their ancestors, as mentioned in the Torah, was not dictated by tradition alone.

The system of *r-p* after death presented in the Torah at first glance contradicts widely held ethical principles. These maintain that when moral regulations are enforced, the guilt of the fathers does not extend to the children. Such a principle may be found in the Torah itself. "The fathers shall not be put to death for the children, neither shall the children be put to death for the fathers: every man shall be put to death for his own sin" (Deuteronomy, 24:16).

However, there is no real contradiction between the responsibility of the children and personal responsibility. A person's actions primarily affect those close to him. Those directly affected are the person's children, grandchildren and great-grandchildren (i.e., three or four generations). They are in the position to absorb the most by imitating their father. On the other hand, a father is in a position to witness three or four generations. It is perhaps necessary for three or four generations to pass before the aftermath of a bad deed on the part of the father, even if it is not brought up, dies out completely. After that, memory of it should have no affect upon future generations. Jeffrey Tigay (1996), making ample reference to authorities on Judaism, writes: "Living to see three or four generations of descendants is as long as one could naturally live. Thus God extends punishment only to descendants the guilty are likely to see in their own lifetimes. This indicates that the suffering of the descendants is intended as a deterrent to, and punishment of, their ancestors, not a transfer of guilt to the descendants in their own right" (p. 66).

Memory of a good deed should not be limited to three or four generations, but should pass on to future generations. The prestige associated with the name of one who has done good deeds may carry over to his descendants, and their belonging to a certain family may play a significant role in their lives.

SEMIUNCONDITIONAL AND UNCONDITIONAL VALUATIONS

Killing and Murder

In investigating a problem as multifaceted as morality, I would like to focus on only a few of its aspects.

As noted previously, morality encompasses fully unconditional, unconditional and semiunconditional values. A comparison of these last two is of special interest, since they play the greatest practical role.

It can be assumed that the ten commandments found in the Old Testament are primarily semiunconditional values. Indeed, I could propose a corresponding commandment which displays unconditional values for the majority of them. For example, the semiunconditional directive "Thou shalt have none other gods before Me" corresponds to an unconditional "Thou shalt not accept authority." "Thou shalt not murder" is semiunconditional, "Thou shalt not kill" is unconditional. The same is true of the pairs: "Thou shalt not steal" and "Thou shalt not take the property of others", "Thou shalt not commit adultery" and "Thou shalt not have any sexual relations before marriage," etc.

Let us explore this in greater detail with the example of murder.

Previously I proposed the attitude toward murder held by some tribes in New Guinea as an example of fully unconditional values. Practically speaking, murder is simply considered to be insignificant. Now I would like to focus on the relation between unconditional and semiunconditional values as they apply to the taking of life.

The difference between these two approaches is clearly manifested in the various translations of the Torah. For instance, *The Holy Scriptures* (1955), a new translation based on the masoretic text (a vast body of the textual criticism of the Hebrew Bible), translates the commandment as "Thou shalt not commit murder." In *The Holy Bible*, commonly known as the authorized (King James) version (The Gideons International, 1983), this commandment is translated as "Thou shalt not kill."

Jeffrey Tigay (1996) examines this difference and sternly notes that such a translation of the commandment is too broad. Indeed, *ratsah*, the Hebrew word for *murder* is distinct from *killing*, for which there are other terms, such as *harag* and *hemit*. Kill obviously has the widest range of meanings and involves any taking of a human life. If interpreted widely, it may be applied to all living creatures. Not attempting a specific definition of murder, I will only note that the concept demands, at the very least, that the taking of life be a willful act aimed at improving one's own situation or that of another party.[7]

In literature, condemnation of murder goes far beyond the disapproval of selfish motives. In *The Queen of Spades*, Alexander Pushkin condemns Herman,

the leading protagonist, for murdering an old woman whose secret he wanted to use to ennoble his family. Impressed with Pushkin's concept, Dostoevsky develops it further in *Crime and Punishment*. Dostoevsky denounces the idea of murdering a dirty old woman who is a pawnbroker for the sake of giving her money to hundreds of widows with starving children. *The Brothers Karamazov* takes this idea even further. It condemns the possibility of sacrificing a newborn child, that its body might be used as the foundation of a crystal palace whose inhabitants would be happy for all eternity. Still, Dostoevsky believed it was necessary to help Serbs kill Turkish soldiers in the Slavs' struggle for independence from the Muslims. It seems that the argument between Dostoevsky and Tolstoy is largely over the interpretation of the commandment in question. Tolstoy was opposed to killing of any kind. It is not by chance that he was close to Gandhi and they even carried on a correspondence. It would be hard to imagine Dostoevsky in the same role!

The difference between unconditional and semiunconditional evaluations will become more prominent if we use the same example of "Thou shalt not kill" and "Thou shalt not murder" to illustrate the conduct of man in accordance with his precepts.

In an extreme case, one who follows "Thou shalt not kill" will allow himself to be killed before he kills another. These views are held by one of the Hindu sects in Sri Lanka (the former Ceylon). To the best of my knowledge, the former prime minister of Ceylon, Solomon Bandaranaike (1899-1959), belonged to this sect. He did not allow himself to kill an attacker and was murdered. As he lay bleeding to death, he did crawl over to the murderer and knock the pistol from his hand before it could be used against his wife, Sirimavo Bandaranaike. She later became the prime minister of Ceylon-Sri Lanka.

The reader will note justifiably, that this view of killing is fine when one believes in reincarnation. After being released from its present body, the soul moves on to another. Furthermore, the better it is preserved, the better its next body will be. Eventually it reaches nirvana, merging with the universal absolute and escaping the suffering which inadvertently accompanies joy.

But how do things stand with a person who belongs to modern Western civilization and attaches significant value to his body? Well, killing can still be avoided, as manifest in the non-violence resistance movements. Very informative in this respect is the story of the village of Le Chambon in south of France. During World War II the inhibitions of this village, lead by their priest, André Trocmé, professed nonviolence but still succeeded in saving thousands of people who were persecuted by the Nazis, notably the Jews. Philip Hallie's wonderful book (1979) details this movement which did not resort to violence although there seemed to be no other way to resolve the movement's objectives. The great force perpetrating this evil included Gestapo as well as the French collaborationists from the Vichy government. Moreover, the inhabitants of Le Chambon had to deal with maquis who thought violence is the only way to deal with the German occupation force and the French collaborationists.

Hallie shows all the hardships associated with the actual implementation of the nonviolence ideology. The book reveals the incredible preparatory work

performed by the village priest and the predisposition on the part of the people of this village to heed his words. Hallie's book presents a convincing case that the implementation of nonviolence in such extreme situation is indeed possible!

However, what happens in other less localized situations when violence cannot be avoided?

In order to answer this question, let us first compare the actions of various tribes of North American Indians. Some Iroquois tribes followed the principle "do not kill." If they were attacked by an enemy tribe, they tried everything in their power to avoid war. If this was not possible, and they were backed into a corner, they would fight. Since they were a powerful people, they usually won. Following a victory, they would sit in the forest and ask the gods to forgive them for spilling the blood of their own people and of the enemy. It is interesting to compare this behavior of these Iroquois tribes to that of other tribes under the same circumstances. After defeating attackers, the victorious tribe would celebrate their success with drums, the enemies' scalps, etc.

While Judaism is dominated by semiunconditional moral directives, it also takes into account the unconditional values of these directives. For example, in a commentary to *The Passover Haggadah* (1969), Ernst Goldschmidt notes that pouring a little wine from the cup at the mention of each plague, which looks like deliberate waste, was originally intended to avert ill-fortune by safeguarding against immoderate rejoicing. Goldschmidt further notes, that Samson Hirsh and Eduard Beneth interpret "this custom as a symbolic tempering of the joy of the evening, in order to show sympathy to the misfortune of the Egyptians" (pp. 40-41).

As Irving Greenberg (1988) mentions, on the first two days of Passover the complete Hallel (a part of the Jewish religious service, consisting of Psalms 113-118) is fully recited. "Thereafter, part is omitted—as a mark of mourning for the Egyptians who drowned in the Red Sea. The Egyptians were vicious taskmasters, yet their pursuing army consisted of sons of Egyptian mothers and fathers. Later generations of Jews felt empathy with the pain of their parental loss. The death of any human being is a sorrow" (p. 58).[8]

And one more comment. The Kohen who killed—even accidentally—cannot officiate in the Temple (Talmud, Tractate Berakhot, 32b).

Justification and Repentance

It seems reasonable to assume that pragmatic values would preclude the need for moral claims. At most, moral considerations could be used as a guide in establishing legal norms.

This assumption might be tested by further examining the role of moral and pragmatic claims in an ethical system. Numerous discussions with theologians have led me to believe that they see moral claims as providing initial guidelines in the classification of the vast body of possible behavioral patterns. They guide the development of conditional social values for actions, since these prove so numerous that it is easy to get caught up in a very rough sort of appraisal (i.e., a division into positive and negative acts).

However, the role of unconditional values can be twofold. They can serve as generic values and determine the sphere of variegating conditional values. They can also function as constraints and have a value in and of themselves.

While I do not deny that moral claims serve as guides, I believe that they play a more significant role. Often a positive or negative sign of these limits can be identified (i.e., making them unconditional). Perhaps moral claims provide *strategic* (global) *constraints* when the problem is *tactical* (local). Unconditional values prove especially important, since the outcome in such cases is unclear.

As soon as such constraints are introduced, there is a penalty for their violation. The form of this penalty can vary. The first of these can be a violation of personal dignity. This is a destruction of those fertile structures which have been developed in the course of evolution, and which, in the long run, aid further development. In this case, a person who has violated moral constraints must not *justify* his action. He should repent, that his character not be violated further. Pragmatists, on the other hand, maintain that the individual's first priority is to achieve success. If the means used prove destructive, this will have only distant consequences and is of secondary importance. Both pragmatists and morally oriented persons will consider the effects of the means used in addition to the success achieved. But the pragmatic approach hinges on the practical utility of violating a constraint. A moral approach focuses on repentance for breaking a moral directive.

The moral approach can be easily derided: The concept of "sin and repent, sin and repent" is comical. Morality is not expressed in a single act of repentance, but in the general dynamic of behavior. The morality of a person will be reflected at least in the first derivative of his behavior function. Put more simply, to what extent will his transgressions of moral directives decrease over time? A reasonable appraisal of human behavior will look at the dynamics of a person's transgressions, and not at the state of the person's character.

This can be applied to many of the phenomena which are the subject of pointed discussion in the Western world. These are questions such as the admissibility of abortion, euthanasia, the suspension of extraordinary medical treatment, etc. The discussions usually deal in extremes. One group justifies abortion or euthanasia, the opposing group condemns it. It seems to me that the arguments may be redirected. Repentance for the taking of a human life is of paramount importance. Justifying such an act destroys an individual's biological values, of which the preservation of life is a powerful component. If pragmatic considerations push one to such actions, they should not be justified. Rather, they should be viewed as an evil unavoidable in the given situation. If this concession to pragmatic considerations involves an expense, it should be covered by the individual who is breaking the moral directive, by a charitable organization or by other means that usually do not involve the government funds.[9]

THE LEGAL FORMULATION OF VALUES

These values may be applied to real situations with varying degrees of exactitude. Here it is crucial to single out those social statutes formulated with explicit reference to these values, and those formulated without such reference. Moral statutes are characteristically presented in the form of demands to do or not do (prohibition) something. There is no explicit reference to the extent of the reward-punishment for their observance. These values are implicitly marked as either positive or negative: what should be done and what should not be done. For example, the ten commandments, which I associate with morality, express only what should or should not be done. Consequences for the observance/ violation of each of these commandments (at least as relates directly to the person involved) are not stipulated (see Exodus 20:1-14; Deuteronomy 5:1-18). This can be contrasted with the statute from Leviticus 24:17: "And he that smiteth any man mortally shall surely be put to death." The latter I shall relate to legal norms.

This does not exclude the possibility of crudely ranking moral statutes within the bounds of the specific markers they are assigned[10]

There are many assertions in the Torah which, in accordance with the demands noted above, relate to morality. Like the Ten Commandments, set forth in Exodus and repeated in Deuteronomy, these sections of the Torah contain many unconditional statutes. Chapter 19 of the book of Leviticus involves such unconditional statutes as "neither shall ye deal falsely, nor lie one to another" (11); "Thou shalt not curse the deaf, nor put a stumbling-block before the blind" (14); "Ye shall do no unrighteousness in judgment: thou shalt not respect the person of the poor, nor favour the person of the mighty; but in righteousness shalt thou judge thy neighbour" (15); "Thou shalt not take vengeance, nor bear any grudge against the children of thy people, but thou shalt love thy neighbour as thyself" (18).

The ten commandments do hold a place of particular importance among other moral statues: they were written by God on tablets of stone.

How well grounded are our methods of applying moral statutes to real situations? We now return to this question. The legal system (including—and this is important—the religious system) was organized with a view toward the most thorough possible integration of various social values, mainly pragmatic. The legal system includes laws which not only strictly formulate social directives, but also explicitly express the rewards-punishments for their fulfillment. It also entails the establishment of a judicial apparatus for enforcement.

Laws provide a better indication of the conditions that form social values; they tend more to the conditional side of the value spectrum. Thus, for the sake of simplicity I will term *pragmatic values*, including *customs*, *laws*.

Although the law accepts all the necessary premises for the formation of fully conditional values, each of these premises is only partially accepted. Allowances are made, as the diversity of real-life situations is richer than any law. For this reason, final judgment on the global exogenous fully conditional value of an act in a given situation is reserved for the subject, who answers directly for the identification of the act. In legal systems, this subject usually bifurcates in complex situations. The identification of an act of behavior forms a dichotomy

dichotomous. Whether or not the violation took place (guilty or not guilty), the decision to sentence to capital panishment are entrusted to a jury; direction of the trial, which paves the way for the jury's decision and the determination of a concrete, conditional response to the act, is entrusted to a judge. In some legal systems, such as England's, there are no laws: early judicial opinions are used as precedents for later judgments in analogous cases.

In order to achieve explicit results (legal expression), moral statutes usually pass through pragmatic values. This is, however, not obligatory. (A detailed investigation of the legal expression of moral norms is given in Sonsino [1980].) In cases where a commandment is sufficient to determine the legal consequences, the Torah clearly introduces it as the legal norm of punishment.

Thou shalt not take the name of the Lord thy God in vain; for the Lord will not hold him guiltless that taketh His name in vain. (Exodus 20:7)

Honour thy father and thy mother, that thy days may be long upon the land which the Lord thy God giveth thee (Exodus 20: 12).

And he that blasphemeth the name of the Lord, he shall surely be put to death; all the congregation shall certainly stone him; as well the stranger, as the home-born, when he blasphemeth the Name, shall be put to death (Leviticus 24:16).

And he that curseth his father or his mother, shall surely be put to death. (Exodus 21:17).

As a rule, in those cases where the commandment is sufficient to determine the legal consequences, the Torah clearly introduces it as the legal norm of punishment with the corresponding exceptions as applied to specific situations (in analogy with linguistics where there are rules and exceptions). For example, the death penalty for murder is stipulated in Leviticus 24:17, but exceptions are given. The Torah indicates special cities of refuge for a person who has unintentionally murderd someone (Numbers 35:6, 11-15, 25-28; Deuteronomy 19:1-13).

The development of Judaism saw exceptions introduced to the Torah's commandment to observe the Sabbath. The Torah says: “Six days shall work be done, but on the seventh day there shall be to you a holy day, a sabbath of rest to the Lord: whosoever doeth work therein shall be put to death” (Exodus 35:2). The Rabbis later found exceptions to this statute: the violation of the Sabbath was permitted when it was necessary to defend the country or prepare food for a sick person.

However, the commandment “Thou shalt not steal” (Exodus 20:15) does not constitute a general legal norm, as the punishment for theft varies with different situations. A series of legal statutes in the Torah deals with specific types of theft and various punishments. “And he that stealeth a man, and selleth him, or if he be found in his hand, he shall surely be put to death” (Exodus 21:16). “If a man shall steal an ox, or a sheep, and kill it, or sell it; he shall restore five oxen for an ox, and four sheep for a sheep” (Exodus 22:1). “If the theft be

certainly found in his hand alive, whether it be an ox, or ass, or sheep; he shall restore double" (Exodus 22:4).

Taking into account the various classifications of social values and the rigors of their application, we can now elaborate on the concepts of morality and pragmatic values noted above.

By morality, I mean the system of exogenous global values which encompass the part of the spectrum composed of fully unconditional, unconditional and semiunconditional valuations of behavior without reference to the seriousness of the consequences. By pragmatic social values I mean the system of exogenous global values encompassing the part of the spectrum that includes fully conditional, conditional and semiconditional valuations of acts, with reference made to the seriousness of the consequences.

BIOLOGICAL AND SOCIAL VALUES IN AN INDIVIDUAL

The Structure of Human Feelings

Human (and not only human) feelings, in contrast to reflexes, offer a means of making choices in conditions where it is necessary to combine several alternate possibilities.[11]

All feelings come in pairs. They possess an initial magnitude and are evaluated in accordance with the extent of positive or negative irritation. For instance, consider such feeling as fear. It represents an initial parameter which indicates danger. Fear varies, that is, it can be strong or weak. The human brain also forms a valuation of fear, that is, its importance in order to collate the valuation of fear with that of other feelings.

Man has the ability to integrate diverse feelings and to make decisions regarding the expedience of certain actions.[12] This is based on the determination, under given constraints, of the need for various inputs to excite/suppress these feelings.

In general, integtation of diverse feelings concerns the formation of a predisposition to the development of a human being. From this point of view, let me say a few words about the structure of the set of feelings. Feelings feature both essentials (material parameters) as well as positional parameters (relational parameters). It is possible that *biological drives* and *vibrations* (*daint-pain*) are related to essentials, and *emotions*—to positional parameters. Biological drives are the internal processes of an organism which deal with periodically obtaining necessary substances or excreting unnecessary ones. They are obviously essentials, connected with the need for food, water, etc. and expressing themselves in feelings of hunger, thirst, etc. The feeling of vibrations—changes in the structure of the body which can bring about positive excitement (daint) as well as negative excitement (pain, which signals the degree of trouble experienced by an organism's material structures)—is just as clearly an essential parameter. The various emotions, however, such as fear, envy, anger, curiosity, etc., express relations between people and their environment (this does not rule out their role in the internal mechanism of imagination).

The vulgar understanding of human behavior considers essentials to be independent variables, and positional parameters—dependent. From this, vulgar materialists conclude that if people's material needs are satisfied, human relations will automatically change and the earth will experience peace and plenty. However, if positional parameters are also independent, then as material needs are satisfied and their marginal utility recede, positional parameters will play an increasing role.[13]

It is evident from the animal world that variously local and global endogenous values are insufficient to make a society function. What are the reasons? Endogenous valuations are unequally distributed among various animals in each group. Certain institutions, and a leader in particular, are necessary to bring to reason those individuals who cause disorder. The set of individual prohibitions-rewards—local exogenous values—and global exogenous values. In a case of a leader, it is difficult to say to what degree the values of the leader express varyingly conditional exogenous global values and to what degree they are his local endogenous values. In him these are intermingled.

We can now posit that a positional style of behavior based on endogenous and exogenous values is encoded in the brain. This does not rule out this style's alternation with a combinational style. In part, this may be linked to the dangers of this style directed toward the achievement of material things. The danger lies in getting carried away, dropping one's guard and becoming a victim. Is this not the source of shame as a means of protecting oneself from falling victim to the combinational style?

The Biological Origins of Human Values

It is quite plausible that the human feelings are innate, that is, they have biological origins. (In computer terms, they are hardware, not software.) One can also suppose that biological values play an important, if not the decisive role (at least for some people) in decision making. In the extreme cases subject to psychiatric research, the individual is incapable of taking into account any values except for his endogenous biological values.

In the extreme cases studied by psychiatry, the individual is incapable of taking into account any values except for his endogenous biological values.

However, biological values are insufficient for a person to make a decision. Decision-making presumes all manner of endogenous values worked out during individual development as well as exogenous global and local values.

The pathos of the liberal point of view derives from its conception of the system of personal values as formed only under the influence of environment. Man is born, in the view of the great English philosopher John Locke (1632-1704) as a *tabula rasa*. The conservative point of view held that in the extreme individual behavior is determined by in-born values. Of course, in nonextreme situations liberals recognize the role of endogenous values, and conservatives recognize exogenous ones. But in all cases the two groups differ in emphasizing either endogenous or exogenous values in individual behavior. For this reason liberals subjected to scathing criticism the view of genetics' essential influence

on human behavior. The liberal view had certain advantages in conditions where the individual's biological basis could not be changed. The possibility of perfecting the individual by changing his environment inspired certain hopes of perfecting society. The conservative view, with its emphasis on accepting the individual as he is, leaves no room for such hopes, it would seem. Meanwhile, in the extreme such a liberal point of view was fraught with the danger of making people less responsible for their actions, as everything was ascribed to the external environment.[14] Truly effective systems were essentially based on the view that an individual's biological particularities are of paramount importance. The idea of the invisible hand, put forward by the great economist and professor of ethics from the University of Glasgow, Adam Smith (1723-1790), quite clearly relied on the premise that to create an effective society one must consider people as they are and then create conditions for their behavior so that their inherent values can be directed as much as possible to the good of others.

Totalitarian systems such as Communism held the negative view of the part played by endogenous values in determining individual behavior in a particularly extreme and degenerate form. They attempted to create a new individual to replace the one already perverted by a capitalist society. The environment, by means of cruelty, has produced a faulty individual. This supposedly persists in people's consciousness as the vestiges of capitalism and the individual had to be reformed in a new environment (primarily in labor camps) by means equally cruel. At the same time, dissenters were exterminated on a mass scale. Their views stood in the way of the true utopian society to be built. Even though they could have been reformed in the labor camps, it was more important to destroy them as an example to others. These were precisely the kinds of considerations inculcated by the people concerned with building communism in theory and practice. They categorically denied the biological basis of human behavior, and viewed the person purely as a product of his environment.

Thus, a person develops a positional style of behavior, different from the one provided him by nature. Since the biological style and the parameters which accompany it are oriented toward a different environment, the developed by a person positional style and inhereted by him biological style can be contradictory. Meanwhile, developments in genetics increasingly point to the significant role of biological factors in determining an individual's behavior.

I would like to suggest that one of the dominant contradictions in the development of Western civilization and its extroverted culture is caused by a conflict between an artificially created environment and the endogenous values inculcated in man. Prior to addressing this contradiction, I would like to digress briefly, and touch upon a category which I term *sensory correlates*.

Sensory Correlates

If one divides the results of human behavior into *final* (existing at the given moment, satisfying hunger and thirst, propagation of the species, etc.) and *intermittent* (eating, sexual intercourse, curiosity, fear, etc.), then it is immediately obvious that sensory valuations involve intermittent as well as final results.

At the same time, these valuations may be concerned with essentials as well as positional parameters.

The sensory valuations of essential parameters provide a strict correlation between the action at the given moment and a *definite* future result. For example, the high sensory value on the act of intercourse is correlated to the high value placed on the act of childbirth, distant at the time. This correlation may cause an individual to act locally based on the criteria of maximization of the difference between positive and negative sensations (within certain limits, of course; otherwise there is no driving force). It is curious to note that certain aboriginal tribes in Australia saw intercourse and childbirth as unrelated acts and attributed childbirth to a divine will.

The correlating factors may be more closely related. There is only a brief interval between eating and the absorption of necessary nutrients by the organism. In this case, the act of eating and satiety each acquire independent values. These correlations have been investigated rather creatively by researchers concerned with the hedonistic aspects of physiological psychology (Stellar, 1985).

Sensory valuations of positional parameters usually provide a strict correlation between an act at the given moment, and a future result which is *indefinite* but is related to the individual's development. Thus, a high value placed on curiosity may be related to the search for new territories, which in the future might somehow become a significant part of the resources on which the individual's development depends. Evaluations of friendship and other interpersonal relations may be treated similarly.

One may suppose that a breech of sensory correlates will have an adverse effect on an individual's behavior. I will provide two such examples relating to the above-mentioned conflict between an artificially created environment and endogenous values.

The first of these pertains to the problem of obesity in economically prosperous nations, particularly in the United States. It is a basic example of a break in the correlation between consumption of certain products and satiety. The biological drives represent an in-born system by which we evaluate the nutrients we consume. In this system, hunger primarily reflects a lack of sufficient nutrients to meet the individual's current demands. Since there is some uncertainty as to the availability of necessary nutrients, the organism is also equipped to create reserves. The size of the reserve depends primarily on the availability of the substance in question. For example, since air is widely available, the organism's reserves are very small, and a person can survive without it for but a few minutes. Water is less available than air. The organism's reserves are higher, and a person may go without water for a few days. Fats, vitamins and other nutrients may be unavailable for much longer. Thus, the body's reserves are large enough, that, in cases of scarcity, a person may survive for quite a few weeks.

In creating an artificial world, man has ensured that he will have sufficient nutrients at his disposal. All the same, a person often continues to increase his reserves, which are not limited by the biological drives. As his level of culture increases, a person attempts to check the growth of reserves by regulating food consumption and physical activity. He sometimes fails, perhaps because the

biological drives are very strong, and it is difficult to control them through reason. The situation is made worse by the kinds of foods a person consumes. Natural foods are much blander than the artificial foods now consumed. Overstimulation of the sensory receptors is accompanied by an increase in pleasure, and it is easier for the organism to receive more nutrients than it requires for its needs and adequate reserves.

The second example of a disruption in the sensory correlate, a conflict between a person's biological values and an artificial environment, may be drawn from a person's ability to kill members of his own species. A person is endowed with agression, which can have a high sensory valuation. Everything depends on the way this valuation correlates with the valuation of other acts, which might bring very negative results.

As was already mentioned in respect to conscience, this is the valuation that is involved in the sensory correlate. It prevents the killing of a member of one's own species. It is well known that when the weapons involved are more powerful, the percentage of fatalities increases. Thus, when two fighters are unarmed and limited to hand-to-hand combat, deaths are rare. In large part, this is due to a person's in-born reaction on seeing his opponents blood and the expression on his face, which prevent the killing of a fellow human being. However killing, even on a mass scale, becomes easier as people come to posses more powerful means of destruction and the distance between opposing parties increases.

The above made statements can be partly illustrated for the year 1994 by the American statistics of murder by different weapons (U.S. Department of Justice, 1995). If one takes the total number of murder victims (22,075) for 100 percent, the percentage of victims by personal weapons (hands, fists, feet, pushes) was 5.3, by firearms 70.0, and by knives or cutting instruments 12.7 (p. 18). If one takes into consideration the total number of killings, including soldiers and civil people during wars, the percentage of victims by personal weapons is becoming minuscule.

Unsuccessful Attemts to Stop Killing Human Beings

No ideology, not even religion, has been successful at preventing us from killing our own kind. It is difficult to determine whether such ideologies were at all beneficial. Even as they preached peace, they would inspire fanaticism and often construct elaborate justifications for the resulting bloodshed. World War I is a good example. The Christian monarchs of Germany, Russia, and England, three of the warring parties, were closely related. They also maintained a correspondence during the war. None of this prevented them from going to great length in refining the weapons to be used for a more effective annihilation of troops.

The conflict between biological values and those formed rationally in conjunction with an artificial environment has perhaps long been expressed by various peoples. It is possible that this conflict is reflected in the legend about the Garden of Eden and the Tree of the Knowledge of Good and Evil found in the Torah. In addition to intuitive conditional valuations of the things they used, the

ability to discriminate food according to taste, Adam and Eve also displayed intuitive unconditional valuations of knowledge and beauty. This is the way Eve perceived the Tree of Knowledge: "And when the woman saw that the tree was good for food, and that it was pleasant to the eyes, and a tree to be desired to make one wise, she took of the fruit thereof, and did eat, and gave also unto her husband with her; and he did eat" (Genesis 3:6).

It can be assumed that for Adam and Eve, the various parameters of relations were less developed. Thus, they did not know shame. "And they were both naked, the man and his wife, and were not ashamed" (Genesis 2:25).

The Tree of the Knowledge of Good and Evil apparently expanded a number of intuitive valuations, perhaps those primarily involving relations. More importantly, it provided a consciousness of valuations.

Why did God forbid Adam and Eve from touching the Tree of Knowledge? There are various interpretations of the Tree's essential meaning (Tigay, 1971). I find a proposed interpretation which relates its role to the civilizing of human rationality quite convincing.

In accordance with this interpretation, one may speculate on the reasons that the Torah's authors attributed to what they saw as God's prohibition.

Contact with the Tree of Knowledge awakened man's creative powers. Upon partaking of its fruit, man immediately realized his nakedness and began to create.[15] But since man was unaware of possible consequences, his creations could pose a threat to himself and all other things on earth. Even God could be unaware of the baneful consequences of his Creation (Genesis 6:5-7), and needed to cause the Great Flood. What could be expected of man? And God, who possesses great powers, can correct unforeseen results. For man, a weaker and less experienced being, this could prove to be impossible. Man came to posses the criteria of good and evil and immediately, God punished him, that he may know suffering and be afraid to create what he cannot control. God wanted to limit man's ability to create something which could have irreparable negative consequences.

At the time of the Torah's writing, the Hebrews, as some other nations (Greeks, Chinese, Hindus), were already well acquainted with various technological innovations. They might have been concerned that these innovations could be used for the purpose of destruction.[16] It is not incidental that the Torah condemns things invented and created by man with the exception of the invention by Jacob—rods of fresh poplar, ans of the almomd and of the plane-tree with pilled streaks in them for making cattle of a particular color (Genesis, 30:37-42). At the same time, all inventions conceived by God, whether actually made by God or man, are given a positive value. Perhaps this reflects the permissibility of inventions if they are produced under the control of people, allowed by existing laws to represent God on earth (Katsenelinboigen, 1989*d*).

It is further possible that the prohibition placed on the Tree of Knowledge is related to a fear that people could create beings more powerful than God. As presented in the Torah, God is not all-powerful. He does not create the world instantaneously, but took six days and a seventh day to rest. There is therefore no reason to assume that man cannot create beings more powerful than the ac-

cepted God, thereby destroying the relations established with Him. Man is presently faced with the possibility of building a computer more creative than himself, a situation quite similar to the possibility of creating beings capable of surpassing an imperfect God. And man does not know how he would control such a computer.[17] Perhaps for these reasons the Torah's creators justify that man was expelled from the Garden of Eden and kept from the Tree of Life. As long as man is mortal, there is still a hope that he can be bound if he goes to far in his quest for perfection.

In summary, I view *the way of life* as a generic term denoting human values. It can be classified based on different criteria, notably the degree of uncoditionality of the respective values. Within this framework, the moral code belongs to the unconditional part of the spectrum, while laws and customs belong to the conditional part of the spectrum. Besides informing a whole slew of conditional values, morality figures prominently as an category in and of itself; that is, as a strategic constraint which aims to prevent us from succumbing to the tempting gains dictated by tactical considerations. All ideologies, including religions, have sought to provide human beings with incentives while making them conform to certain constraints. Fascinating in this connection is the fusion of unconditional values (for instance, do not kill) and the real-life conduct of human beings (for instance, repentance rather than justification); people are also mindful of the behavior of the first derivative of one's conduct. However, history of mankind, full of mass murder and other crime has shown that nothing can eradicate these evils. One plausible explanation for this predicament is the conflict between innate biological valuations (more or less adequate for the environment under which they were formed) and the artificial world man has created. Here, biological valuations refer to feelings—biological drives, vibrationes (daint-pain), and emotions—each of which is represented by a pair of parameters denoting its magnitude and its valuation.

Another approach to the social values is to view them based on endogenous versus exogenous valuations (local and global). This is where the category of *conscience* comes in. It represents an endogenous global valuation—endogenous because it is intrinsic to an individual, and global because it embodies the environment in its totality. This quality, in conjunction with endogenous local valuations characteristic of the given individual (in effect, defining his individuality), allows man to be perceived as a *microcosm*.

Ethics shall refer to a *metaconcept*, which incorporates a wide array of fundamental principles which inform morality and law as well as reconciles the valuations (which vary in terms of degree of uncoditionality) typically employed under different circumstances.

NOTES

1. Interestingly, the English expression way of life corresponds in meaning to the Hebrew *derech erets*, which literally means path of the world.

The Russian word *nravstvennost'*, which unites moral and ethical meanings, has the same root as the word *nrav*, character (compare the Greek *ethos*—character) and *nravy*, mores (compare the Latin *morales*—custom). As for the Greek and Latin words, they

correspond, as I note later, to the English terms *morals* and *ethics*.

2. Rifat Sonsino (1980) proposes a very interesting hierarchical classification of legal formulations found in the Torah. The initial division is two-fold: conditional and unconditional, with the latter also termed *apodictic*. Each group is classified further:

I. Laws in their conditional form
  A. "When/if" form
    1. Third person
    2. Second person
    3. Mixed forms
  B. Relative form
    1. Third person
    2. Mixed forms
  C. Participial form
II. Laws in the unconditional form
  A. Direct address
    1. Positive commands
      a) Preceptive imperfect, second person
      b) Imperative
      c) Infinitive absolute
    2. Negative commands
  B. Third person jussive
    1. Positive commands
    2. Negative commands (p. 17).

I concur with this classification of social statutes, but ascribe greater importance to the initial division into conditional and unconditional. Readers interested in a detailed decoding of this classification will find the corresponding materials in the Sonsino work cited above. Here I focus primarily on other types of classifications. They do not contradict the one cited above and even intersect with it at times.

3. One can see in the Torah the employment of some of these reasons in passing judgments. Isolating the criminal from society can take the particular form of subordinating him to a master-owner. So if, for example, a thief lacks the means to make restitution, that is, "if he have nothing, then he shall be sold for his theft" (Exodus 22:3). At the extreme, isolation from society can take the form of the death penalty.

The idea of the criminal compensating for the harm he has done is highly developed in the Torah. It is enough to cite the example of corporal compensation. "And if a man cause a blemish in his neighbor; as he hath done, so shall it be done to him; Breach for breach, eye for eye, tooth for tooth: as he hath caused a blemish in a man, so shall it be done to him again" (Leviticus 24:19-20). This is in addition to the various material and financial compensations for harm which are frequently indicated in the Torah.

It stands to reason that compensations, like isolation from society and capital punishment, can serve to deter crime, and if one excepts the death penalty, to aid in re-education. The latter is particularly evident when the compensation exceeds the initial value of what is lost. Compare in the Torah the amount of the loss with the amount of the compensation in various cases of theft: the compensation at times far exceeds the loss. For example, "If a man shall steal an ox, or a sheep, and kill it, or sell it; he shall restore five oxen for an ox, and four sheep for a sheep" (Exodus 22:1); "If the theft be certainly found in his hand alive, whether it be ox, or ass, or sheep; he shall restore double" (Exodus 22:4).

4. Yury Koriakin drew my attention to this problematic, remarking that the Russian word *sovest'* is composed of two parts: *so-vest'*.

5. Because in chess there is a clear final goal, its spectrum of values is limited; the fully unconditional values are becoming not constructive.

6. Russell Ackoff told me of his research on the poor sales of Volvo trucks on the African market. He discovered that these trucks had safety features to protect the driver, which led in turn to a noticeable increase in production costs and price. Ackoff's hypothesis was that in poor African countries where human life is worth little, it doesn't make sense to buy more expensive, safer trucks. To test his hypothesis he compared outlays for fighter pilot safety in the United States, England, and France. He hung a table with the data in his office. Later, a colleague from the Economics department was in his office, saw the table hanging on the wall, and asked Ackoff in surprise why he had taken it upon himself to determine per capita national income in various nations. In fact, the data for pilot safety outlays correlated exactly with the nations' level of GNP per capita.

7. The frequently encountered descriptions of murder as something illicit (Tigay, 1996), *unlawful* (*Webster's New World Dictionary*), do not illuminate the issue, as there are no clear criteria for determining the illegality of taking a human life.

8. Analogous remarks on God's stand toward the destruction of enemies can be found in (*Talmud*, 1984), pp. 48-49.

9. In light of the interpretation of moral statutes I have proposed, one can critically approach Russell Ackoff's (1994) definition of what he calls *mechanistic ethics*. "The mechanistic approach to ethics conduct, much like a computer program, involves the formulation of rigid rules. Adherence to these rules is taken to constitute the good; virtue equals conformity. The Ten Commandments, the Golden Rule, and Kant's Categorical Imperative are examples of such rules" (p. 53).

I agree with Ackoff that it is sensible to single out mechanistic ethics. I also concur with the view he advances in the work I have cited: that it is extremely difficult to ground moral-ethical statutes and the contradictions which arise between them. I also agree that it is frequently quite difficult to establish the extent to which an act constitutes a violation of these statutes.

But I do not share Ackoff's opinions on the following questions. A minor formal comment: I would first divide the examples he cites into two groups, moral and ethical. In accordance with the above-mentioned classification of morality and ethics, some of the examples can be treated as ethical. It seems sensible to me to treat the Ten Commandments as moral statements, and the others—the Golden Rule and Kant's Categorical Imperative—as ethical principles. Significant criticisms can be leveled at the examples of mechanistic ethics in connection with the fact that, in my view, moral statutes are not simply crude, programmatic prohibitions. They are, as I have shown, primarily social constraints which play an enormous role in strategic decisions. In this sense, the prohibitions are close to the social systemic ethics proposed by Ackoff (1994).

10. I illustrate this assertion, like many others in the chapter, with examples drawn largely from the Torah, which contains much relevant material on the problems I treat here. Aside from the masoretic text of The Holy Scriptures (1955), I refer to the latest detailed, fundamental research on the problems which occupy me in this chapter. Among these I single out Tigay (1996) and Sonsino (1980).

11. The material presented on feelings relies on a joint project I completed with Daniel Giacomo and Mona Weissmark (Katsenelinboigen, 1989*c*).

12. The process of integrating sensory valuations remains unclear. There are at least two varieties: either all sensory valuations are homogenous and thus amenable to direct

comparisons, or they are heterogeneous and their local significance for the organism can be viewed via their global evaluations (like in economics).

13. Noteworthy in this connection is the following excerpt from an essay written by Alexander Genis (1996). "Japanese female author Reiko Khatzumi recounts the following experiment: Biologists populated an isolated island with birds and provided the birds with plenty of feed. Instead of enjoying this life of plenitude the birds turned aggressive and began to fight, pillage other birds' nests, and destroy their eggs."

14. My son, Sasha, many years ago noted that liberals are inclined to make fewer demands upon individual responsibility for one's actions, so if genetic research on behavioral determinants was scientifically authenticated, it would not be surprising if the liberals begin to fervently defend the decisive role of genetics in human behavior, just as they had earlier denied it. In recent years several liberal publications (for example, *The New York Times Book Review*, December 24, 1995, p. 16) have shifted their attitude toward the work of sociobiologist Edward Wilson. Previously he was seen as an extreme conservative accused by several critics of being a racist.

15. Curiously, man's first creation was not tools, but the loincloth; not means, but a final product—clothing. Perhaps upright locomotion rendered the male reproductive organs vulnerable; the loincloth protected them. (The significance of the loincloth for females requires further research.) This invention was clearly momentous, as it powerfully impressed the creators of legends.

16. In connection with the current discussion of the Torah, I would mention that the noted Sumerologist Professor Samuel Kramer (1981) from the University of Pennsylvania found a number of facts confirming a hypothesis by Professor Arno Poebala, a well-known Sumerologist also at the University of Pennsylvania, that the Sumerians were ancestors of the Jews.

The late Professor Boris Moishezon (1984), whose work takes into account the most recent discoveries in archeology, linguistics, history, etc. on the pre-Sumerian period, elaborated a very original theory of pre-biblical Jewish history that places people possibly representing pre-Jews at the center of technological progress.

17. See Isaac Asimov's book (1970); in a more general fashion, the uncontrollability of humankind's own creations is presented in William Wymark Jacobs' story (1975).

5

ECONOMY

ECONOMIC SYSTEM AND ITS INDETERMINISTIC NATURE

It seems appropriate to warn the reader that this chapter is a continuation of my book (1992), and therefore it may be a little hard to follow without reading the book first. In order to make the reader's job easier, I will briefly repeat some of the important conclusions of my book along with the discussion of the main ideas of this chapter.

Economic Systems versus Social Systems and Chess

Clearly, economy is a lot more complex than any game including chess. At the same time, economic system is relatively less complex, easier to characterize and, generally, more deterministic than any social system. What is important, however, is the affinity between games and economic mechanisms, on the one hand, and between the patterns of social evolution and economic dynamics, on the other. Therefore, I believe that the ideas concerning games, as well as social dynamics, that are presented below, may help further our understanding of economic systems.

In general, any economy is a protracted system based on R & D, production, exchange, distribution and consumption of goods. Each of these processes features its respective mode of operation characterized by different degrees of indeterminism. But, because all of these processes are continuous in time, one key problem which arises in economic as well as other systems, is linking the current state of the system with the future (past) state of the system when "the time is out of joint."

The analogy between games and economic systems is more elusive. One cannot deny the fact that competitiveness is inherent in both games and markets, but in games the players follow the well-defined rules, while the complex inter actions between economic agents in the real world can rarely be described by the collection of simple rules of behavior.

Two opposite approaches towards the idea of using games as approximation of the strategic situations that the firms may encounter in the market, can be found in the article by Raymond Smith (1996), the Chairman of Bell Atlantic, and in the article written jointly by professors Scott Armstrong and Fred Collopy (1996). The title of Smith's article, "Business as War Game: A Report From the Battlefront," suggests that he is very enthusiastic about the idea of using game theoretic models in formulating the firms' business strategies. The authors of the other paper, however, are more cautious; they recommend that managers, as well as management academics, "avoid using sports and military analogies, because they foster a competitor orientation" (p. 197).

I will return to the discussion of Armstrong's and Collopy's article and present my interpretation of their findings. First, let me focus on the most transparent distinctions between the economic systems, on the one hand, and social systems and games, on the other.

In chess, for instance, the rules are formulated outside the game and are fixed for the entire duration of the game. In the development of societal systems, the only *external force* is nature. The evolution of an economic system, having its own internal dynamics, is *externally* affected by the *social* systems as well as directly by *nature*.

These features of the economic system inform the general direction (orientations) of economic development, which is to increase the satisfaction of the material needs of the people, no matter how the latter are defined. The needs themselves are unlimited, if only because we live in a universe which present unlimited opportunity for exploration by humanity.

Naturally, the general course of development of economic system, that is, introvert versus extrovert mind-set, determines the rate of development. In the socioeconomic literature, the distinction between these two types of orientations is known as *sociological dualism*, the term introduced by Julius Herman Boeke in 1978. Let me quote Gustav Ranis (1988) speaking on sociological dualism:

> There is, for example, a so-called sociological dualism which stresses cultural differences between Western and non-Western type of economic organizations usually associated with the name of Boeke. Such dualism emphasizes the differences in societal objectives, with Western economies driven by economic goals and Eastern societies by social or non-material goals. (p. 74)

Our subsequent discussion will focus on economic systems characterized by extrovert orientation.

The study of social systems emphasizes the interactions among people in a society, while the study of economic systems to a great extent focuses on production, distribution and exchange of goods and resources. This may be the reason why a deterministic way of resource allocation that lack the *human touch* is so common in economic theory. The approach described above is similar to the methodology used in physics. Lev Rozonoer (1973) suggested a term to de-

scribe the deterministic models used in economics that is isomorphic to the models in physics as *resource dynamics* (by analogy with thermodynamics).

A model that incorporates the human nature of economic agents does not belong to this class. Even the most trivial deviation from the resource dynamics model introduces new human parameters into the model. For example, the fact that people cannot maintain the same level of intensity, precision, and productivity suggests that the production outcome must depend on technological parameters as well as on the specific (human) characteristics of the workers.

As far as the standard approach towards modeling the managerial structure of economic system is concerned, there is one important point that I would like to make. In any economic system, whenever one encounters a multi-level managerial hierarchy, irrespective of whether it embraces the entire economic system or only part of it,[1] the decisions that are to made at each level of this hierarchy cover different time spans. At each level of the hierarchy, the purposes formulated for the lower levels are retained and new ones, that call for a broader perspective (both in terms of time and space) are introduced. For example, low-level management is usually in charge of operational decisions, the mid-level management makes tactical and operational decisions, and the senior management controls both operational as well as tactical and strategic decision making. The rationale behind this is simple. The structure of the described decision-making process ensures that none of the decisions will result in a suboptimal outcome for the organization as a whole, because the short-term decisions are always bound by the constraints generated by solving the mid- and long-term planning problems. For instance, the operations managers often tempted by short-term success, heed the long-run consequences of their decisions.

Sources of Economic Indeterminism

The crux of the classical economic doctrine was to steer the economy toward a state of equilibrium (optimal state). One needs only to look at the many new methods of preventing and recovering from depressions and recessions to realize how much progress has been made in this area. In the ideal case, the classical approach is founded upon a deterministic scheme in which the future is predictable and the key task is to work out a program of action.

I believe that the indeterministic nature of economy limits the usage of the concept of optimal (equilibrium) allocation of resources.

There are at least three sources of economic indeterminism. The first one has to do with the growing importance of the elaboration of new ideas in the modern economy, a process which, due to the deep disruptions at the stages of R & D, cannot be exhaustively described by any deterministic schemes. The second factor is human relations, which, I believe, can be viewed as horizontal constraints on the process of resource allocation. Finally, there are various exogenous disturbances that affect the orientation of an economic system. Such disturbances originate outside the economy and constitute either political changes (war, for example) or new social developments.

In my opinion, the crucial step from deterministic to indeterministic vision of the economy is associated with Joseph Schumpeter. For him, the cornerstone of development of an economic system was promoting disequilibrium. This aim is attained via spontaneous entrepreneurial activity which introduces technological and organizational innovations. The task of the economic institution is two-fold: to promote entrepreneurial activity while keeping the system from disintegrating. Given these objectives, the key aim is not to attain the state of equilibrium (optimum) but to delimit a feasible space (let me call it the *schumpeterian space*) which is conducive to entrepreneurial activity and) prevents the system from disintegrating.

Translating this two-fold objective into the language of indeterminism means that the system's predisposition is defined not as a state, but as space featuring institutions and rules of interaction which promote development.

With respect to economic systems, a democratic political system represents a prototype of this kind of predisposed structure. This multidimensional entity includes such facets as the pluralistic mechanism (characterized by diverse institutions such as a multiparty system, free press, etc.), the separation of power, competent and responsible individuals partaking in the decision-making process, the country's openness, etc.

I have tried to superimpose a similar structure upon the corporate world, calling the result a *trapezoidal corporation* (Katsenelinboigen, 1995).[2] Its key feature is that its top level is plateau-like stage upon which the aforementioned manifold of corporate's political institutions (with no center but according to certain rules) interacts. The opposite type of a corporation is the more common pyramid-like corporation which tapers off with the corporation leader. The reader will find a detailed discussion of a trapezoidal corporation (called something else) in chapter 17 of my book (1992*b*) in the section which deals with multidimensional organization of a firm.

The indeterministic mechanism of performance of an economic system, manifest in the diverse institutions and rules of their interaction in the feasible space, does not preclude the creation of predispositions via the state of a system or a program.

In order to give the reader a better picture of what I mean by economic indeterminism, I will reiterate some of the ideas presented in my book (1992) concerning the sphere of research and development—R & D.

One problem where the indeterministic approach towards economic analysis can generate results that are non-trivially different from the standard microeconomic findings, is the relation between the production process and the rapidly growing sphere of R & D.

At the early stages of R & D, when the potential applications of fundamental research are not known, the product of research cannot be evaluated by any market mechanism. However, the financial support for this research could be secured through non-market horizontal mechanisms, based on the principles different from the ones that require consumer's evaluation of the final product. For instance, the institution of tenure in universities is an example of such a mechanism. Tenure, being an assessment of the potential scholarly product, offers a

certain degree of freedom (independence) to the researcher: the opportunity to work on specific tasks (teaching, for instance) for a limited number of hours and devote the rest of the time to the research projects of his/her choice.

At the point where an *external expert* assessment of the potential worth of the new product (in terms of the prospective demand for it) becomes possible, a new class of non-market mechanisms comes into the picture, notably institutions guided by expert evaluations of the new product. Private foundations are one example of such non-market mechanism.

Once the new product is almost ready to be tested on the market, other types of financial mechanisms, suitable for different levels of product maturity, can be introduced. At the early stages of this process, when one can start manufacturing the new product, but the demand for it is still unknown, the uncertainty may be of two kinds. If there are similar products on the market the risk involved in putting out the new product can be estimated probabilistically on the basis of statistically observed frequencies. Otherwise, the uncertainty has to be quantified using different methods. For instance, one can try to judge the creator of the new product in so far as his predisposition for inventing a realistic and market-friendly product.

The sources of financing also differ depending on the risk involved. When uncertainty is high, it is predominantly the small companies or individuals who work with *venture capital* that are willing to invest in the development of the new products. Subsequently, when uncertainty is at least partially resolved, other institutions, such as investment companies or even commercial banks, enter into the picture.

Another interesting question is whether or not the vertical, centralized, comprehensive planning mechanism can be used as an alternative to the various non-market and market mechanisms described above. As I have already pointed out, in the early stages of the R & D process, the non-market horizontal mechanisms seem most adequate for the task. There are exceptional cases that require governmental (vertical) intervention. These cases concern development of new avenues in R & D that require huge amounts of resources not available to private organizations. The government funds can be also valuable as an addition to private funds. But even at the stage where product development is sufficiently advanced, however, the vertical mechanisms lack the required flexibility. Large bureaucracies often turn out to be extremely inefficient in identifying the reasons behind the poor performance of a new product. In particular, it would be unrealistic to expect that the question of whether the failure is due to the market not being ripe for the new product or to the organizational (managerial) mistakes can be resolved impartially within a large bureaucratic or government organization. Consequently, the investors themselves must bear full financial responsibility for the consequences of their decisions.

Obviously, it is impossible to foresee in detail the outcome of the creative process. Therefore, when there is not enough certainty that the research in a given area will lead to the production of the new viable good (once again, when "the time is out of joint"), the horizontal mechanisms, based on decentralized decision making and private property seem to be the best available option.

Perhaps, given the modern-day level of technology and progress in economic theory, the vertical (centralized) resource allocation scheme could perform quite efficiently if there is an opportunity to accumulate enough statistics via *trials and errors* or if there were no new products as such.[3]

Thus, economic indeterminism is rooted in the category of development and on the basis of it the creation of predisposition is oriented toward more effective movement in the desired direction.

PREDISPOSITIONS AT THE MACRO LEVEL

This section will be divided into two parts. The first part concerns long-term development of economic systems; the second and much smaller part focuses on the predictability of the short-run tendencies of the stock market.

Predisposition to Development: The Long-Run Tendencies

Economists have come up with a number of definitions of economic development, each emphasizing a different aspect of economic development.

In the following definition given in chapter 3, Russell Ackoff (1994) stresses the *functional* approach: "Development is an ability and desire to satisfy one's own need and legitimate desires and those of others" (p. 45).

Cynthis Taft Morris and Irma Adelman (1988) define development using the *structural* approach:

> Economic growth is a quantitative phenomenon. In the modern era it means that per capita GNP rises even as population grows and as human and other resources move out of agriculture into sectors of higher productivity (Kuznets, 1968). Economic development involves quantitative changes in the distribution of labor and output between sectors, in sources of household income, and in the composition of consumption, savings, and investment. However, the essence of economic development is qualitative change: change in the relationships among individuals, classes and political groups; and technological and institutional change in the ways that production, distribution, and consumption take place. Above all, development means dynamic evolution. (p. 3)

The definition of economic development that was introduced by Joseph Schumpeter (1961), emphasizes the *procedural* approach to development. According to Schumpeter, development is "a distinct phenomenon, entirely foreign to what may be observed in the circular flow or in the tendency toward equilibrium. It is spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium previously existing" (p. 64).

Each one of these definitions captures certain important aspect of the concept of economic development. I would like to suggest a unified approach which fuses Ackoff's functional definition with the structural and the procedural ones. Let's divide the parameters used to characterize an economic system into

two categories: (1) the manifold of the elements comprising an economic system (including the fundamental rules of their transformation) and (2) the mechanisms that integrate and hold the system together. Joseph Schumpeter was the first economist to suggest that the primary contributor to the successful development of economic system are the entrepreneurs whose seemingly random actions enlarge the above mentioned manifold and often veers the economy away from equilibrium. The mechanisms that hold the economic system together define the *feasible space*—the constrained set of admissible states of economic system, which presumably contains the equilibrium states as well. The primary objective, however, is not necessarily to find the steady state, but to facilitate the path of economic development that satisfies certain stability requirements and, at the same time, is characterized by the maximal possible conditions for the entrepreneurs. It seems that the development of the western economies follows the scenario outlined above.[4]

What would be an adequate measure of economic development? Allow me to express some ideas that in no way claim to represent a final solution to this fascinating problem. First of all, one should bear in mind that the problem of measuring the level of economic development is part of the more general problem of measuring the level of social development (the latter is found in chapter 3). A measurement technique is needed that would allow us to estimate the level of importance (weight) of the essential as well as positional parameters.

Armed with the concept of predispositions, one can suggest that the economic development is measured by a weight function of many variables that incorporates not only semiconditional valuations of essential (material) parameters—Gross National Product—but also semiconditional valuations of positional parameters.

One of the problems with the standard method of calculating the dynamic of the GNP, for instance, is that it is not invariant to the choice of the constant prices (base year prices), because the choice of the base year itself is often arbitrary. I can suggest the method of calculation of the dynamics of GNP that would be consistent with the indeterministic approach; my book (1992) discusses some ideas regarding the application of the Turnpike Theorem in calculating the semiconditional prices for the essentials that constitute GNP.

Another problem that arises in the measurement of economic development stems from the fact that it is very hard to specify the set of positional parameters and assign weights.

The simplest solution to the problem of measuring economic development was suggested by Simon Kuznets (1966). He split the process of development (termed *Modern Economic Growth*) into several stages. Each stage was characterized by the magnitude of essential as well as positional parameters. To each stage was assigned a higher degree of development if *all* of its parameters were changed in a desirable direction (the Gross National Product was rising, the infant mortality was decreasing, etc.).

In general, such an approach seems to be too restrictive, since it is rarely the case that all the relevant characteristics of economic system always change in the same direction. Moreover, as Moses Syrquin (1988) notes, one other draw-

back of Kuznets' approach was that "the amount of information assembled by Kuznets was enormous, but he did not use formal statistical techniques in its analysis. This task was later taken up by Chenery (1960)" (p. 214).

Hollis Chenery (1960) measured economic development using Gross National Product for the evaluations of essentials and various methods of regression analysis to determine the impact and therefore the importance of different positional parameters.

Since very often we are confronted with the problem of insufficient data, it may be impossible to estimate the weights and derive a holistic valuation of the country's level of development. When this is the case, Amartya Sen (1988) suggests the following method of estimating the level of economic development:

> It should be clear that the perspective of functionings[5] and capabilities specifies a *space* in which evaluation is to take place, rather than proposing one particular formula for evaluation. The exercise has to begin with the identification of valuable functionings. In the context of economic development, there might well be considerable agreement as to what functionings are valuable, even though there might be disagreement on the *relative* values to be attached to the different functionings. When an agreed list has been arrived at, the approach of "dominance" provides a *minimal* partial order on that space (in terms of greater achievement in *every* respect).
>
> To go further than this will require more articulate evaluation functions. But these evaluations need not be based on a unique set of "indifference curves." The relative values may be specified as belonging to particular ranges, and corresponding to such specification of ranges, the overall ranking may be a partial order more extensive than the minimal dominance order but probably well short of a complete ordering. (p.18)

Predispositions to the Short-Run Tendencies of the Stock Market

Although the problem of predictability of the short-run tendencies of the stock market was on the minds of many economists for a very long time, there are surprisingly few papers on this subject in the economic literature. Besides the simple models that attempt to extrapolate the patterns of the stock price fluctuations, some attempts have been made to determine the positional parameters that might influence the stock market. These techniques could be interpreted as an attempt to predict the stock market by its predispositioning.

A study by Robert Nurock, discussed in Louis Rukeyser's book (1974, pp. 266-268), is one such attempt. Most of my remarks below will contain references and quotes from this book.

Nurock suggested ten indicators for predicting the changes that can occur at the stock market within the three-to-six month period:

1. An advance-decline index: the number of stocks that went up versus the number of stocks that went down
2. A Dow-Jones Momentum Ratio: comparison of today's Dow Jones Industrial Average with its long-range trend
3. A New York Stock Exchange High-Low Index: measuring every day number of new highs and lows
4. A Market Breadth Indicator: the reinforcement of the first indicator on the basis of a ten-day moving averages on the net advances or declines
5. An Institutional Block Ratio: keeping track of the urgency of buying or selling by the big boys
6. A Low Price Activity Ratio: comparison of the weekly volume in the Barron's Low-Price Stock Index with the volume in the seasoned blue chips of the DJIA
7. An Odd-Lot Short-Sales Ratio
8. A New York Stock Exchange Specialist Short-Sale Ratio
9. A Weekly Tabulation of Advisory-Service sentiment
10. A Bond Market Indicator.

Let me make some comments concerning these indices.

One obvious stipulation for each index is that its "predictive value, whether for the next minute or the next millennium, is certainly not guaranteed—least of all by a skeptic like me." From the methodological point of view, the choice of the forecast period (three-to-six month) is interesting; it merits comparison with the set of these indices designed for predicting the daily and weekly trends on the one hand, and, say, the annual trends of the stock market on the other hand. Unfortunately, I did not find the proper sources for such a comparison.

Under this approach, the weight assigned to each index is determined independently of the weights assigned to other indices. As a result, the accuracy of predictions is lower than it would have been if we knew how these indicators feed off each other. For example, the first of ten indicators was correct for 1961, 1966, 1969, and 1970 and wrong for 1963 and 1964.

In this model, each index has the same weight. However, the analysis of the positions in chess as well as the PIMS model suggests that better results can be obtained if the valuations of positional parameters are not identical.

The Nurdock's model oversimplifies the issue of assessing each indicator of the stock market and correspondingly the stock market predisposition in general. "With the difference between the number of indicators showing positive readings and the number negative is 5 or more the index is thought to be clearly indicating a coming change in the market's direction." As a result, his estimate of the predisposition of the stock market to move in a certain direction are not always accurate.

Donald Keim and Robert Stambaugh (1986) approached the problem of predicting the changes that can occur at the stock market differently. They used a much smaller number of indicators in order to predict only certain aspects in the stock market behavior. Their indices are relatively more complex, and, more important, they are integrated into one function that is used for their forecasts.

Three indicators, introduced by Keim and Stambaugh, allowed them to assess *ex post* "risk premiums on common stocks of NYSE-listed firms of various sizes, long-term bonds of various default risks, and U.S. Government bonds of various maturities." One of the indicators concerns the bond market and the other two, the stock market.

1. The first index is the "spread between yields on low-grade corporate bonds and one-month Treasury Bills."

2. "The stock market variables are (i) minus the logarithm of the ratio of the real Standard and Poor's Index to its previous historical average and (ii) minus the logarithm of share price, averaged across NYSE firms in the quintile of smallest market value."

"The three variables are related inversely to levels of asset prices, and consistent with a simple valuation model, the variables are positively correlated with future returns."

As far as I know, attempts to predict the future behavior of the stock market using this approach were unsuccessful, although they might have had some heuristic value for the market players.[6]

To conclude our discussion of the predictability of stock market behavior, I would like to suggest the list of positional parameters for the evaluation of the predispositions of the stock exchange that was developed by me in corroboration with a former student of mine at the University of Pennsylvania, Joel Friedman. This rather speculative general set of parameters draws upon the earlier work with another student of mine at the University of Pennsylvania, Jacob Schultz, that consisted in analyzing the structure of the chess positions, firm's position in the market, etc. The reader will find this set of parameters in my book (1992*b*).

Unfortunately, the practical implications of this set of parameters was never tested. Therefore, at this point, it is not possible to determine the reasonable time span, within which the suggested indicators might work, or to assign the numeric values to any of these parameters. My hope is that the idea of estimating the predisposition of the stock market through the subjective assessment of its positional parameters will stimulate some interest to this area of research.

Of course, the analysis of stock market behavior cannot be complete if we limit ourselves to the description of the relevant positional parameters. We also need the semiconditional valuations of the stocks (essentials), obtained from the generalized model of "turnpikes", that is, this model would explicitly incorporate the financial institutions. Once the theoretical part of the work is complete, one can start thinking about the empirical applications.

PREDISPOSITION OF THE FIRM TO DEVELOPMENT

Deterministic and Indeterministic Perspective on the Firm

Any standard deterministic microeconomic model places economic agents in one of two categories: consumers or producers (firms).

The consumer's problem resides in maximizing his utility function subject to budgeting constraints.[7] A utility function is determined by biological needs and the social environment, that is, it is coming from the outside of an economic system. However, as soon as this function is formed, it is becoming to a great extend independent from the economic envitoment and that is why it can be treated as an *internal criterion*.

The firm's problem consists in maximizing its profit based on prices as global parameters of the economic field.[8] It is an *external* criterion because it is fully depended on the economic environment.

The study of economic life crystallizes in addition the notion of *the managers internal criteria of performance.* A number of researchers, particularly, Tibot Scitovsky (1943) and Oliver Williamson (1963), have turned their attention to the fact that it is the manager (*not* the owner!), who strives to increase personal income in the broadest sense of the word, including not only monetary recompense, but also perks like a luxurious office, the best secretarial services, and so forth.

In this case, what we see is a familiar conflict between the firm's external criterion of performance based on profit and the manager's internal criterion of success, which raises the issue of relationship between the level of the manager's private income and firm's income. As a result, the owners of the company face the complicated task of coordinating external and internal decision-making criteria and constructing incentives for managers that ensure the best possible reconciliation of all the vested interests.

In the ideal case (within the deterministic framework) the external criteria of firm performance and the manager's internal criteria coincid if both seek to maximize profit.

Once we adopt the indeterministic view of economy, then assessing the firm's economic activity by its leaders, solely on the basis of the external criterion of profit, becomes insufficient.

For one thing, the information about the future prices (even in terms of probabilities) is limited by the horizon span, so it is impossible to determine the firm's present orientation on the basis of market prices. The firm's predisposition to development in the future in this case consists in using semiconditional prices for essentials and building up certain relations between the firm and the economic environment, which include the relations between the firm and the producers of the same or analogous products, the relations between the firm and its distributors as well as the suppliers and so on. This entire network of business ties can be characterized by the positional parameters, such as market share, product mix, the degree of horizontal and vertical integration, the firm's share in the revenue from a new product and technology of its production, etc.

Here, the *external criteria of the firm's performance* is manifest in an *objective* and a *subjective* form. The *objective external criteria* refers to the class of performance criteria (based on the firm's profit) predicated upon the assumption that the market prices actually encapsulate the totality of all the various subjective criteria of the firm's performance. The *subjective external criteria of the firm's performance* assumes the form of a weight function with the material

parameters assessed in semiconditional prices while the weights of the positional parameters are set by the firm's leaders in terms of their perception of another participants' assessment of the firm's position.[9]

The gap between the generated profit and the magnitude of the subjective external criteria reflects just how well (realistically) the firm's leaders (both, as owners, as managers) had assessed the economic environment.

At the same time, the firm's leader develops his own *internal criteria of performance*. This criteria captures the material parameters (assessed in semiconditional prices) as well as subjective valuations of positional parameters. The latter are based on the leader's perception of his own personal capacity to develop the company in some particular environment and given the magnitude of the external subjective criteria of performance.

To examine under these conditions the interplay between the internal and the external criteria of the firm's performance, let's consider the simplified case, when the commodity being sold/bought is the entire company.

As I learned from my conversations with Norman Gross, who was involved in the purchasing and selling of businesses, the valuation of the firm was based on the assessment of both positional as well as essential parameters. The buyer's valuation of the business is based on his internal criterion of the firm's performance. Usually, the seller's perception of the company's market position did not matter that much, unless the buyer plannes on keeping the same personnel.

There is ample literature on how to estimate the value of a business. However, the analysis is usually limited to the consideration of the most simple objective parameters that characterize the firm's performance, revolving around the concept of profitability. The procedures of buying a company, the buyer's subjective valuation of the object of trade were never analyzed in details.

In the conclusion to the *Review of Business Valuation Methods*, a paper that was written a few years ago by my graduate student at the University of Pennsylvania, Greg Lichtenstein, several issues were pointed out:

1. Only essentials are evaluated by these methods.
2. Each method focuses on the maximization of a single variable, in some cases subject to certain constraints. No attempt is made to integrate several variables using any one method.
3. Positional parameters are not prominent mentioned; it is suggested that they be taken into account in order to make adjustments to the calculations produced by the various methods. No methods are proposed for evaluations of these parameters.
4. The process of selecting representative comparisons and adjusting for the differences is not explicitly addressed by any of the methods.
5. Inability to link the current state of the business with its future earnings stems from the lack of statistics required for the extrapolation of past trends.[10]

This is, in fact, a sufficiently accurate picture of the state of research on the subject of assessing a company's value. Clearly, there is no distinction between

the stage where the buyer's subjective valuation of the company is formed (the internal criterion of the firm's performance) and the bargaining stage, where the price at which the object of trade will be transferred is determined.

The aforementioned deterministic models are helpful in understanding how the consumers' internal criteria based on personal valuations of the various goods is complimented by an external criteria that is based on a set of prices (on goods purchased/sold); that is, prices being the global parameters of the economic field. Deterministic mathematical models feature an elegant fusion of these two criteria. It would be interesting to construct a generalized Arrow-Debreu general equilibrium model for the indeterministic economy and devise an algorithm for attaining the maximal possible efficiency in the framework of this model. Hopefully, it should help us understand how prices are formed in the indeterministic economy and therefore to design a price mechanism consistent with the indeterministic nature of business management. In general, this idea is consistent with my view of the role of mathematics in economic analysis. I believe that not only should one be allowed to translate the real-life economic problems into the language of mathematics, but one should be able to translate the mathematical methods of solving the formalized economic problems back into the language of economic mechanisms and their real-life applications.

To conclude the discussion about the variety of criteria of the firm's performance, let me reiterate the distinctions between the deterministic and the indeterministic efficiency criteria.

The deterministic efficiency criterion is based on profit (an external criterion of the firm's performance), which depends only on the essential variables (input-output) and their conditional prices. All the modifications of this criterion, apart from profit, are formulated using essentially the same set of variables. Beside the external criterion of the firm's performance, the internal criterion was sometimes considered, but it's analysis was usually reduced to the observation that the managers seek to obtain personal rewards from the firm rather than increase its profit.

The indeterministic efficiency criterion differs in the following respects: (1) the internal and the external subjective criteria of the firm's performance are based on the evaluation of the firm's predisposition to development; and (2) the relationship between the internal criterion and the external objective criterion (profit) is different: instead of focusing on the possible conflict of interests between the managers and the owners of the firm, it focuses on determining the firm's predisposition to change and grow.

Objective and Subjective Valuations of Positional Variables

Let me start with a few remarks concerning the selection and evaluation of positional parameters incorporated into the criteria of the firm's performance. I want to focus on the firm's overall strategic direction which shapes the economic environment. The two general cases which arise in this context are the firm introduces a new product to an *unsaturated* market versus the firm introducing a known product to a highly *saturated* market.

In the first instance, the firm induces the environment primarily by cooperating with other firms, for fast development and introduction of new products to the market promises much greater returns than the competitive framework. In the U.S. we have witnessed this kind of cooperation, for example, in the development of new electronic devices. In the second case, that is, the market is close to being saturated, a firm (even one innovating on the existing technologies) is primarily concerned with marketing its output and competition from other companies (see note 20 in chapter 4).

Given that the valuations of positional parameters are interdependent, the valuation of such parameters as the share of new products in the firm's output or the firm's market share will obviously depend on such positional parameter as the level of market saturation.

Firms differ in their ability to carry out any given strategy. Consequently, any attempt to argue for the firm to increase the output of innovative products will fall on deaf ears, since these calls are unconditional and oblivious to the firm's capacity to carry out the proposed strategy.

Generally speaking, the assessment of positional parameters is a highly complex task, which embodies a host of conditions.

Consider, for example, such positional parameter as *proximity*. The fact that two companies specializing in production of the same good are located close to each other may have positive as well as negative effects on their performance. Suppose the firm is a jewelry store, and there are several other jewelry stores in the neighborhood. On the one hand, this will clearly create spatial competition, but on the other hand, it may attract more customers because of the larger selection and greater price range. Also, being located in the same area, the jewelry stores may actually save on their security expenditures by organizing a unified security network. What is interesting is that different owners, when choosing the location for their business, will put different weights on different factors.

The last statement leads to the next topic—the objective and the subjective facets in the assessment of positional parameters.

The original subjective evaluation of the situation by the decision maker is critical in the creative strategic management. Subjectivity of the managerial decisions is inevitable due to the intrinsically indeterministic nature of the strategic management, meaning that the subjectivity arises not just because of the lack of scientific foundation in business management. The effective approach to the strategic decision making, as demonstrated in the game of chess, presupposes that each player has a unique, individual vision of his strategic position. To make it more systematic, one should not substitu te the player's intuition with some objective laws that relate essential and positional parameters, but rather complement the intuition with the statistical analysis.

All this certainly does not easy apply to the real world.[11] Because managers usually do not own the companies they work for, they either have to come up with some objective (statistical) justification of their subjective decisions or simply reject the efficient subjective decisions in favor of the more standard, but scientifically corroborate strategies. Sometimes, the managers simply make up

the data to support their decisions, which eventually ruins the business ethics of the company.[12]

Thus, are so attractive the scientific methods for objective evaluations of a firm's positional variables. In this context, the model PIMS (Profit in Market Strategies) merits a close examination. Sidney Schoeffler, the founding director of The Strategic Planning Institute (SPI), established in 1975, is one of the people who initiated the development and the promotion of PIMS (Schoeffler, 1991).

The PIMS model is based on enormous amount of information from its firms-clients—250 leading companies of North America and Europe, representing 2,500 businesses (by business I mean division, product line, etc.), each characterized by more than 100 indicators. At first, the SPI focused on the analysis of the effect of separated positional parameters, such as the market share, the degree of vertical integration, etc. on the companies' ROI (Return on Investment). Later on, the research shifted to assessing the linkages between the essential parameters, positional parameters, and profitability. Once we have these functions, the valuations of their variables are given by the partial derivatives.

Shoeffler's analysis of the relationship between the investment-intensity and the width of the market segment that is covered by the firm is one example of the type of analysis that was described above. The problem with any capital-intensive production, whether it is mass automated production or a completely new product line, is that initially the rate of return on investment is low. One of the goals of this research project was to determine the valuations of positional parameters such that the capital-intensive production could be, on average, sufficiently profitable. "An investment-intensive business can be quite profitable if it focuses on relatively narrow and conquerable market segment, and covers that segment really well, with a broad and diverse product line tuned to the preferences of that segment" (p. 18).

Also, being able to work with these market functions not only allows the firms to determine the general orientation of their development, but also to relate the tactical problems to the strategic objectives. Thus, "large-share business must pay a short-run cost in terms of reduced ROI, while small and medium-share businesses are able to increase short-term ROI and market share simultaneously. (Over a longer time horizon, however, large-share business will reap the ROI benefits of having a higher level of market share)" (pp. 22-23).

Finally, this approach should help the managers to find the non-trivial solutions to the problems and avoid the standard, common sense type of decisions. Shoeffler's analysis of the relationship between the company's market share and the changes in the size of the market illustrates how misleading the conventional wisdom can be: "Large-share businesses, on average, lose share in rapid-growth environments, while weak-share firms gain share in such environments. Equally surprising, large-share businesses fare worse than weak-share businesses in negative marker-growth situations.... It was the large-share businesses in rapid-growth markets that the conventional wisdom suggested would achieve the greatest share gain" (pp. 21-22).

In my book (1992*b*), I discussed the positive facets and some of the drawbacks of this model. Here, I would like to limit our discussion to a few comments. Ambitious as it may sound, the model was designed to provide a scientific basis for business management based on the *objective market laws.* that are similar to the laws in natural sciences. As I mentioned in the Introduction of this book, the concept of laws as leading rules governing a system is more relevant to natural sciences, and, particularly, to physics, because the physical system is relativele stable. It seems to me, that this concept is not relevant to economic systems because the last are highly dynamic.[13]

On my opinion, there is generally nothing wrong with the idea of collecting and analyzing data about different companies' performances in order to determine what appears to be a good decision in any given strategic situation. On the contrary, I am sure that many firms can benefit from having access to such a data bank.

What I believe is important is that the market functions were not supposed to replace managerial craft. Based on personal experience, common sense, "plus native intelligence to a particular kind of problem", these functions should not dismiss the creative aspect of business management. One should not forget that the true artist differs from the craftsman because of his creativity, his keen intuition and his ability to come up with an original (non-trivial) assessment of the predisposition of the creative endeavor at its intermediate, or even early, stages.

I believe that the conversation between Sidney Shoeffler and chess grandmaster Sergey Kudrin can help to define the area of applicability of the SPI's findings. The conversation took place at the symposium *Calculus of Predisposition* that I have mentioned in the Introduction to this book.[14]

Shoeffler asked Kudrin the following question: "Suppose that you have a data bank that contains information about every chess game ever played. Also, suppose that you can retrieve any information on either essential or positional parameters, that you might be interested in, instantaneously. Do you think that such information would be sufficient for you to make an accurate evaluation of the position?" Kudrin's answer was as follows: "If one compares the evaluations of the same common positions given by the two grandmasters their verdict regarding a given position will coincide." (I would like to add here, that this suggests that the statistical connections between essential and positional parameters have been tested in practice so extensively as to neutralize the players' subjective vision, especially, the top level players.) He continues, "In that respect, this data bank might be quite useful to me. However, the information contained in this data bank concerns mostly standard and well-known positions. A grandmaster usually wins because he can introduce original positions or come up with an unexpected series of moves in a well-known position. Then, if we get two grandmasters to analyze novel positions, their subjective evaluations will most likely be different, reflecting each player's individual style as well as his intuition and his ability to develop the new position."

If we heed Kudrin's ideas in assessing the firms' market position, one conclusion would be that the link between essential and positional variables re-

vealed by PIMS may be sufficient for formulating business strategies in the ordinary, well-known situations.

However, due to the variety of products and technologies, and most important, due to the indeterministic nature of economic system, the number of trivial economic situations (especially, for the large companies, where strategic decision-making is particularly important) is significantly less than in chess. Therefore, the subjective valuations of the company's market position by the managers comes to the fore.

Because the highly skilled managers is a scarce resource, they are likely to be found at large companies. Therefore, it should be especially important for these companies to allow their grandmaster managers some level of subjectivity in the evaluation of the strategic situations. It is dangerous to allow such subjective evaluations for managers that are not grandmasters.[15]

I would like to summarize the discussion of the PIMS model with two concluding remarks. First, I believe that Shoeffler's analysis of the relations between essential parameters, positional parameters, and profitability is important. It may enrich the managerial tool kit with the new and creative methods of problem solving. However, I am a bit skeptical about viewing these functional relations as laws, because we do not even know under what conditions they might hold.

Second, as I already explained, I do believe that Shoeffler's findings can be used rather successfully when the firm is operating under familiar, routine conditions, or when the managers of the company know that they are facing the opponents that are less proficient or inexperienced.

But, once again, in strategic business management, the variety of the situations as well as managerial styles dictates the need for the creative and, therefore, subjective evaluation of the firm's market position.

Let me illustrate the practical importance of these ideas using as an example the firms' concern with such positional parameter as market share.

Market share is perceived pretty much in the same way by all firms. The pricing policy of the company, whose goal is to increase its market share, is almost always. Scott Armstrong and Fred Collopy (1996) describe the escalation of the price wars and the resulting welfare loss as an inevitable consequence of the firms' desire to increase their market shares; in many situations, the application of competitor-oriented techniques leads to the decrease of the firms' profits. They wrote:

> Many management techniques focus attention on market share. For example, portfolio planning methods examine performance relative to the competitors. Use of these methods seems to be detrimental to profits. In laboratory experiments with 1015 subjects, Armstrong and Brodie (1994) found that use of the Boston Consulting Group matrix as a decision aid substantially reduces the profitability of subjects' decisions. Slater and Zwirlein (1992) concluded from a study of 129 firms that those whose strategies are consistent with portfolio planning models have lower returns to shareholders. Farley and Hulbert (1987, pp. 316-

> 317) found that firms that use the Boston Consulting Group portfolio matrix methods report a lower return on capital than those not using them. (p. 190)

The authors conclude:

> Because of the evidence to date, we believe that micro economic theory, with its emphasis on profit maximization, is the most sensible course of action for firms; that is, managers should focus directly on profits. Our findings also raise concerns about information systems—having information about a competitor's performance may be harmful to a person's own performance. Improvements in the ability to measure market share, first through survey and more recently through scanner data, might lead to a stronger focus on competitiveness and to less profitability. (p. 198)

I like the attraction of the game-theoretic model of Prisoner's Dilemma to analyze the drawbacks of using positional parameters in determining the firm's market strategies.[16] However, the authors are skeptical about using any positional parameter that calls for the firm to sacrifice some of its profit in order to achieve a desirable level of a given parameter. Recall that in the experimental study, discussed by the authors, the managers who were using the objective Boston Consulting Group Portfolio Matrix Methods to find the desirable size of the market share, were actually making less profitable decisions than the ones who didn't.

It is possible that the firms were not very successful in using positional parameters as the guidelines in formulating their business strategies because they always tried to obtain some kind of objective estimates of these parameters.

Assuming all that has been said about the assessment of the company's position under indeterminism makes sense, one should also think about making the corresponding adjustments in the corporate accounting system. Besides profit, the ledger should itemize all the aforementioned parameters which define company's internal efficiency criterion. Subjective assessment of positional parameters is consistent with this kind of bookkeeping, provided the subjective valuations are not equated with objective results.

Changes in corporate law may also make sense. Eric Orts' 1993 article in which he widely quoted my book (1992*b*), evaluates the firm's strategic position and its tactics and points out the following:

> Complex strategic issues involved in modern business management do not easily reduce to a standardized legal formula, even if based on economic criteria. Corporate law must take account of the difficulty of trading off short-term and long-term planning horizons and the corresponding complexity of corporate decision-making that affects shareholders, creditors, employees, and other interested groups. (p. 1594)

PREDISPOSITIONS OF AMERICAN AND JAPANESE FIRMS

In this part I will attempt to compare the behavior of American and Japanese companies by examining their respective approaches to creating predispositions. The observations presented below have certain general significance, since the behavior of American firms is to a large extend similar to that of the British firms, and the behavior of the Japanese firms to that of the German firms.

The Japanese firms direct considerable effort towards creating the predisposition that will ensure their successful development in the long-run. Their perception of successful development consists in moving toward becoming the world's greatest economic power. As Lester Thurow (1992) mentioned: "The Japanese secret is to be found in the fact that they have tapped a universal human desire to build, to belong to an empire, to conquer neighboring empires, and to become the world's leading economic power" (p. 118).

The American companies are often driven by the short-run profits. Therefore, their strategic business style is more combinational.

Clearly, all these differences should result in the different values of essential as well as positional parameters.

Essential Parameters

As far as the Japanese firms are concerned, one of the key criteria of the firms' performance is the value added, which indicates that the owners believe that the salary level, and, more generally, the welfare of their employees, are vital to the company's performance. Maximizing the value added entails maximizing those components of the value added that are related to the employees' welfare (wages and other social benefits) and the owner's welfare (profit), excluding rent and interest payments.

The fact that Japanese companies do not view wages as part of the costs, paradoxical as is may seem, has some rationale behind it. The importance of this approach for creating the predisposition of the firm to the successful development has been emphasized, for example, by Yoshi Tsurumi and Hiroki Tsurumi, the Japanese Professors of Economics, who were teaching at the U.S. universities (1985).

> Accordingly, a firm's behavior of maximizing its value added is more likely to produce two necessary characteristic of flexible corporate systems conducive to the technology-driven growth of the firm; namely, the least resistance of managers and employees to such technological innovations as automated flexible production system and the continuity of people and their shared goals.
>
> Both management and employees become keenly aware that their personal interest is inseparably linked to increase their sales and cut costs of raw materials, parts, and other purchases by improving their firm's productivity and ability to supply innovative products to markets. (p. 35)[17]

Although it is rather common for the American firms to view the workers' salary cuts as one of the ways to increase profits, I believe that Lester Thurow's remark that "for American firms lower wages equal higher profits" (p. 139) is an exaggeration. Not all American businesses share this view. Henry Carey (1793-1879) was one of the first economists who advocated the opposite approach to the relationship between owners and workers in the American business. For instance, Henry Ford, the founding father of the once largest automobile empire, was one of the followers of Carey. In 1917 he even sued his business partner, Dodge, who believed in the classical formula "lower wages = higher profit." After Dodge won the legal battle, Henry Ford became the sole owner of his company, until he died in 1947.

There is another essential parameter that is evaluated differently by American and Japanese companies: the expenditures on research and development. Japanese firms are usually reluctant to reduce these expenditures even if the company's sales are declining. According to Thurow (1992), American firms are more willing to cut their research budgets during economic recession than the Japanese firms (p. 142).

Positional Parameters

The most significant distinction between American and Japanese firms concern their evaluation of different positional parameters.

Japanese firms attach great importance to the positional parameters of the company, provided that the essential variables (such as profit, sales, etc.) do not fall below certain acceptable level. They are even willing to make positional sacrifices in order to be able to improve their future position at the market.

American companies, for the most part, are classic profit maximizers. Being aware of the relevance of the positional parameters, the American firms do not consider them to be as important as essentials.

One of the positional parameters, which is treated very differently by American and Japanese firms, is human relations. The relations between American firms that produce the same goods are almost always competitive, which is legally reinforced by the antitrust legislation. According to Armstrong and Collopy (1996), the American companies are overly competitive and they are wasting too much effort to prevent the competitor's success[18] instead of focusing on making the most out of every situation. Using the simple game theoretic model, The Prisoner's Dilemma, to analyze the firms' strategic interactions, they conclude that when one faces the strategic dilemma "keep your price low, which causes your competition to suffer a substantial loss or choose a higher price that produces higher profit for your firm, but which also allows the competition to prosper," it is reasonable to choose the second strategy.[19]

Unlike the American business relations, the interactions between the Japanese companies are based on cooperation. *Keiretsu* is a typical example of such cooperation. Lester Thurow (1992) emphasized that "seventy-eight percent of the shares listed in the Tokyo Stock exchange are owned by keiretsu member.

Because the majority of the shares of each member of the group are owned by other members of the group, no member of the group can be bought by outsiders. Each member of the group is part operating company, part holding company, and part investment trust" (p. 134).

One of the positional parameters that the Japanese firms pay a lot of the attention to is their independence ("strong and independent empire mentality"). It is extremely important for any Japanese company not to allow any interference in its internal affairs by any company that belongs to a different financial-industrial group.

Thurow (1992) points out the following:

> Given price/earning (P/E) multiples of sixty to eighty on the Tokyo Stock Exchange in the mid- and late-1980's, profit-maximizing firms should have issued and sold shares until their stock-exchang P/E multiples available on government bonds. By selling their shares and buying government bonds until the two markets were brought back into equilibrium, they could have made a lot of money without taking any risk. They did not do so. Something stopped them. That something was, of course, independence. If they has issued those shares, they would have diluted their ownership and control, and they would have made themselves vulnerable to takeovers. A majority of their shares might not have been owned by other members of their business group. (p. 132)

Building good, solid relations between the workers and management as well as between the owners and the managers is one of the priorities in any Japanese firm. The workers are usually very proud to work for the company that has a significant market share.

As Thurow (1992) mentioned:

> The average Japanese employee loves to tell you how he works for a company with the biggest market share in its industry. He or she will even take pride in having the third-largest market share as being a soldier under the third most powerful warlord in the industry. No one from the head of a company to the lowest workers ever refers to a high rate of return on investment as an aspect of success in which one should take pride. Expanding market share is the objective. (p. 142)

The worker's pride of being an employee in his company is supported by various benefits and joint social events. For instance, the ceremony of acceptance into the family of the firm's employees, according to Lester Thurow, is comparable by its importance for the Japanese workers with the importance of being baptized for the Christians.

For a worker leaving his company is equivalent to committing the act of treason (p. 140). The owners are as loyal to their company as the employees. In Japan, the owners rarely sell their businesses (p. 142).

The attitude towards the same positional parameter in the American firms is quite opposite. The mobility of the workforce in the United States is very high. American workers leaveng the companies either because they were fired or because they were offered a better jobs. The same kind of flexibility is common for the owners of the American companies. Owners sell their businesses whenever it seems to be more profitable than owning.

One can observe similar difference in the attitudes of the shareholders in the United States and in Japan. The Japanese firms prefer to distribute their stocks among their employees as well as among the banks and other companies that belong to the same financial-industrial group as they do, ithat is, among the sufficiently patient investors—(ones who feel sufficiently secure and do not discount the future heavily).

The American companies almost always sell their stocks at the open market to the outsiders, that is, mostly to the impatient investors, who expect high short-run (even quarterly) returns on their investments. The largest percentage of stocks of the American companies is owned by the pension and mutual funds.

For the Japanese firms, the key positional parameter is their market share, the epitome of the firm's imperial aspirations. Firm size is an indirect indication of the Japanese mindset. Let's compare the profitability of the American and the Japanese companies: among the 50 largest international corporations, 18 are American based, and only 3 are Japanese. While if we compare their respective sales, it turns out that 17 companies are American and 10 are Japanese. According to Lester Thurow (1992), the dominant view in the American companies is that "fighting for greater market share is irrational to the rational profit maximizer" (p. 133).

At the same time in the study we talked about in the previous sections of this chapter, Armstrong and Collopy (1996) conclude that it is not exactly the case that American companies do not care about their market share, but that whenever they aim at increasing their market share either by using some pseudo-scientific methods developed by the consulting firms, or by developing their own tactics, they almost always fail.

I believe that one plausible explanation of this outcome is that due to the prevalence of the competitive orientation, American firms often have hard time accepting the need to cooperate. Thus, their inability to evaluate the entire spectrum of positional parameters may lead to the relatively inferior performance in the long-run.

There may be, however, another more important reason. Note that sacrificing the short-run profit for the sake of increasing the company's market share in the future is similar to the positional sacrifice in chess, which is evaluated subjectively by the person who is making the sacrifice and who is going to exploit the predisposition gained as a result of this sacrifice. Therefore, the success of such a decision hinges upon a sufficiently high level of proficiency, so that the player would be able to evaluate the position as well as his own ability to exploit the opportunities it presents. Extending this to strategic business management, the probability of adopting a successful strategy based on the sacrifice in essentials is not very high for the average professional manager who has to play

against business grandmasters. While very important, this cause for poor performance is hardly amenable to statistical verification.

Also, in order to prove the validity of a positional sacrifice, the leading executives at American corporations might have to resort to objective recommendations and the functions that reflect the expected (averaged out) contribution of the sacrifice of profit to such positional parameter as market share. There are all kinds of companies which amply provide the decision makers with these objective findings.

On the other hand, because the managers of most American firms do not own the business, it should be very hard for them to prove that the positional sacrifice is reasonable. That is why they almost always need to back up their subjective evaluation by some objective statistical studies. In the Japanese firms, however, due to a very special family culture as well as the structure of the company's ownership, the level of trust between the owners and the employees and, as a result, the freedom that the managers enjoy in making subjective assessments of various positional parameters is much greater.

In summary, let me point out that the crux of the classical economic doctrine was to steer the economy toward a state of equilibrium (optimal state). Gaps which arise en route of development and which could not be patched up with classical probabilities-based techniques, call for the non-classical approach and new methods characteristic of indeterministic processes. These methods are based on creating predisposition toward future development using the proposed (and largely subjective) calculus of predisposition.

It follows from the concept of predisposition, that one should measure the level of development as a function of essential as well as positional parameters, evaluated in semiconditional prices; as far as the exact specification of this weight function is concerned it should be to a large extent subjective.

One of the challenging applications of this idea at the macro level is to develop a new method of calculating the Gross National Product when "the time is out of joint," that is, whenever it is not possible to measure the changes by using the standard chain index. Whenever this is the case, the changes in Gross National Product have to be viewed as an outcome of the process of development, not growth, that is, as that part of the general function of predispositions, that depends on the essentials. But instead of the constant prices (or the base year prices), one should use the new semiconditional prices, that might be obtained from the "turnpikes."

One finds the best examples of the applications of the concept of predispositions to the real economic problems at the micro level. One way or another, the managers of the firms have to take into account the market position of the company as well as its predisposition for future development. They can do that either explicitly, by forming their subjective evaluations of the essential and positional parameters, or they can do so implicitly, simply by compiling the list of all risk factors that can hinder the implementation of the company's strategic program.

The concept of predisposition reveals the importance of subjectivity in the strategic business management. In particular, one can see why certain attempts

to follow the recommendations based on objective valuations of the positional parameters of the firm's performance (notably PIMS) were not very successful.

This view of the firms' position is invariant to the type of the firm's relations (competition versus cooperation) with the economic environment; what is required is that positional parameters be made explicit when forming the firm's predisposition in the market (e.g. its market share). The relationship among the firms certainly affects the valuations of these positional parameters and the way these valuations are reconciled with current market prices. Now consider the essentials: in developing long-range strategy and facing lack of reliable information about the future prices (even in terms of probabilities), the firm may count on the concept of predisposition to replace uncertain prices with new types of prices on inputs and outputs, namely semi-unconditional prices.

The analysis, conducted by Scott Armstrong and Fred Collopy (1996), of the role of positional parameters in formation a firm's behavior, and the firm's market share, in particular, has revealed the importance of my conceptual vision of a position of a firm and the role of subjectivity in the executive's assessment of a situation and its predisposition toward future development. Armstrong and Collopy arrived at the conclusion that the competitor-oriented objectives, one of which was the market share, reduce the firm's profitability. Their recommendation, however, was to return to the classical approach to the business decision-making, based on the profit as the sole objective. The main problem with the positional parameter market share was that in the companies we were looking for some kind of objective valuation of this parameter whereas it must be subjective by its nature.

So far, our discussion of indeterministic methods in economics has been limited to forming the most predisposed state of a system.

NOTES

1. In the central planning systems, the hierarchical managerial structure embraces the entire economic system, from top to the bottom. In the market economies, it is present only at the level of the firm, the government has only a few regulatory functions.

2. Workshop on *A Trapezoidal Corporation*, February 22-23, 1996, organized by myself and supported by the SEI Center of the Wharton School, University of Pennsylvania (Director Jerry Wind) and Johnny Pourdehnad (Interact).

3. During war time, for instance, the centrally planned resource allocation is usually quite efficient even without recourse to modern economic theory. Very few new product are being produced (predominantly the new weapons). The incentive schemes for the managers of the enterprises that are manufacturing the new products may include very strong negative as well as positive stimuli. Since there are very few new products, it is relatively easy to figure out the sources of possible problems (the government can organize special task forces that will investigate each case).

4. Note that in this case, we abstract away from the military factor, for instance, although I realize its importance in determining the orientation of economic system.

In the late 1960s and early 1970s, when I was involved in designing the optimal mechanisms of central planning economy in the former U.S.S.R., I completely ignored all the exogenous social and political factors that could have had some impact on economic development, including the military factor. One of the reasons, of course, was the fear

and the fact that all relevant information was classified. However, the entire economy of the former Soviet Union was oriented at the creation of the military power, which was consistent with the offensive military strategy (although the Soviet leaders never admitted that until the era of *glasnost*). The consumption of the population was viewed as a constraint and was set at its minimal level, given the political priorities. Obviously, attempting to design the optimal economic mechanism without taking into account the military factor, which played the decisive role in the country's development, was naive.

5. I want to add the clarification of the term *functionings*, given in the following quote, that was taken from the same article: "People value their ability to do certain and to achieve certain types of beings (such as being well nourished, being free from avoidable morbidity, being able to move about as desired, and so on). These doings and beings may be generically called functionings of a person" (p. 15).

6. There is one remark, that I would like to make here. All attempts to formalize the stock market behavior using the methodology developed for the natural systems were unsuccessful. Talking to the people who have been working at the Wall Street for quite some time, I learned that the most efficient brokers are the ones with two to three years of experience. Apparently, when they do not have sufficient experience, their intuition is not developed, but when they have more than three years of experience, they consciously try to apply the methods that are believed to work in the natural systems.

7. For the sake of brevity, let me call the budgeting constraint *budco*. As used here, the term emphasizes the versatile constraint (which defines the limits for acquiring any products; see my work, 1978) as opposed to its concrete manifestation in the form of money. In this context, money represents a particular case of budco which features a guarantor, be it a commodity or an institution.

8. Some authors consider alternative measures of the firm's performance based on the modifications of profit, such as revenue, or costs (*asymmetry principle*) and sometimes even focus upon one of the decisive component of profit, all of which are modifications of the same essentials.

A modification of profit is also the criterion return on investment (ROI). There are also other more sophisticated modifications of profit. In 1992 the stock prices of the bioengineering pharmaceutical companies suddenly dropped. In November 1992, people started to believe that they reached the bottom, wondering if it was a good time to start buying again. The natural question that everybody was concerned about was how to choose which pharmaceutical company's stocks to buy. Dr. Viren Mehta, an analyst with Mehta & Isaly Worldwide Pharmaceutical Research, suggested the following indicator: "A company's market valuation—total shares outstanding multiplied by the current share price— relative to its research spending and personnel" (Quoted in Fisher, 1992).

According to Dr. Mehta, the key criteria for evaluating the company's shares had to be such essentials as the total number of staff members and the company's research budget, because these are the main factors that affect the future success of any pharmaceutical company (not its past performance).

9. Interesting in this context is the theory of reflexivity processes elaborated by Vladimir Lefebvre (1977).

10. Points 4 and 5 refer to setting the price of the business; points 1, 2, and 3 refer to the subjective evaluation of the firm's market position.

11. Here is an example of the evaluation of the firm's predisposition excerpted from a book by Peter Lorange (1980):

> This list includes assessment of potential market share and growth rate, potential unexpected obsolescence possibilities, uniqueness of the technological

> strength developed, as well as exposure to environmental regulation. Another checklist attempts to assess the strategic program's potential impact on the present business, i.e., how a business element strategy might fit within the business family strategy. Questions in this respect include assessing the capital needed, constraints, problems within the various functions such as marketing or production, new materials availability problems, as well as whether a program seems to have strong organizational support. (p. 42)

12. "Irangate" was, in some sense, similar to this situation, if we look at it from the perspective of the U.S. leaders who chose to violate the law "for the greater good."

13. An analogous opinion concerning the exaggeration of the role of laws in economics borrowed from the methodology of physics was expressed by George Soros (1997). The arguments that Soros uses to justify his statement are different from mine. Soros's arguments are related to the existence of reflexivity in an economy—a phenomenon that is not observed in a physical system. I do accept Soros's point of view as an additional feature that distinguishes economic and physical systems, that is, a high rate of change and, with it, spontaneity.

14. What made this discussion particularly interesting was that in his articles Shoeffler very often used the analogies between business and chess (sometimes, he even used chess terminology, like "making moves inappropriate to the position"), and, at that time, Kudrin was an MBA student at Wharton School, University of Pennsylvania.

15. In business, as well as in chess, it is not clear how to train someone to be even an expert. Everybody can learn to play chess, but not everybody can become the chess master; not to mention the chess grandmaster. (There are may be 450 chess grandmasters in the entire world!) The same is true in business. Given the same level of education, all that matters is the difference in the people's natural talents and psychological profiles. I realize that this view is rather conservative, since it denies the possibility to train anybody to perform any complex tasks irrespective of his/her natural abilities. But I believe that it is consistent with the human nature. Therefore, there exist two extremes: on the one hand, the importance of subjective evaluations of the highly proficient managers, and, on the other hand, the possibility to replace the routine, primitive decision-making procedures that are used predominantly by the less proficient managers, with the scientifically based procedures. The rest of the business managers can benefit from knowledge of the rules of behavior of the firms at the market by developing their intuition.

16. There is an extensive literature on the application of *Prisoner's Dilemma* to the analysis of business decision-making. See, for example, Friedel Bolle and Peter Ockenfels (1990).

17. Here is the abstract from another article, written by the same authors (1991):

> ... it is argued that Japanese companies diligently track profit opportunities but do not view maximization of short-term profit as an appropriate goal. It is hypothesized that, if Japanese firms are trying to maximize value added rather than short-term profits, then these 2 measures are either uncorrelated or are negatively correlated and that value added, not short-term profits, is positively correlated with the equity of the company. An exact sampling test of zero correlation and a Bayesian procedure are used to test these hypotheses. With financial data from 1970 to 1988 on 6 Japanese semiconductor firms, it is shown that the hypotheses hold for these companies. When value-added maximizing firms (Japanese) meet short-term profit-maximizing ones (U.S.) in a market environment characterized by an unpredictable silicon cycle and the race for

leadership in a new dynamic random access memory generation with large research and development and capital outlays, the value-added maximizing firms fare better.

18. This is in some sense analogous to patterns observed in biological systems. In 1904 Petr Kropotkin wrote: “what is described as competition may be no competition at all. One species succumbs, not because it is exterminated or starved out by the other species, but because it does not well accommodate itself to new conditions, which the other does.” (p. 53)

19. It certainly does not imply that the company should always disregard the interests of the firms it is competing against. Often, the primitive selfish actions may hurt the company. On the other hand, the firm should try not to miss any opportunity to do better than its competitors.

6

AESTHETICS

The preceding presentation of the philosophy of indeterminism—particularly the analysis of the phase of predisposition—and its applications to different systems have finally led to an understanding of the essence of the aesthetic method. Before I start my comments on aesthetics, I would like to make some remarks concerning the relationships among the notions of beauty, the aesthetic method, and aesthetics.

By the notion of *beauty* I mean the explicit evaluation of predisposition of a certain state of a system to its further development. This also implies evaluation of actions that are responsible for transformation of different states of a system, the actions that implicitly convey predisposition (see in detail chapter 1). It seems, that even the feasible space of a system can be a subject for evaluation by beauty;[1] for example, the formation of a schumpeterian space in an indeterministic economic system (see chapter 5). The spectrum of beauty's negative notion pertains to the degree of *ugliness*. The given definition of beauty is fundamental for my hypothesis of its nature.

By the *aesthetic method* I mean a procedure of transformation of states of a system, the states represented as predispositions. It means that the aesthetic method, unlike the scientific method, *never has a final end*. As the Russian poetess Bella Akhmadulina said in one of her poems "I will start here with the end that is also a beginning" (translated into English by Vera Zubarev).

By *aesthetics* I mean a metaconcept that deals with the formation of beauty and aesthetic methods.

Historically, aesthetics was for a long time a part of philosophy related to art. The term aesthetics, derived from the Greek word for perception (*aisthesis*), was introduced by a eighteenth-century German philosopher, Alexander Baumgarten, and was created to distinguish between the perceptual and conceptual (cognitive) methods. This method is usually interpreted to be based upon the sense perception of an object.

In those times, conceptual methods were understood as completely deterministic; they suggested the objective completeness and consistency of all components inherent in a system. For instance, Descartes' deterministic geometry had been counterpoised to sensual methods. However, intuitive attempts to oppose the aesthetic and the scientific, and which parameters are to be used in creating such an opposition, remain problematic. I strongly believe that there is a quite different structure forming beauty, a structure that has often been taken for *sense perception*.

Thus, in the eighteenth century aesthetics separated from philosophy and became a separate discipline tightly connected with art.[2] In the present time, aesthetics is recognized as a self-sustained discipline separated from art and treated as a general systems category that can be applied to any field.[3]

A mathematician talks about beauty of a mathematical result (theorem, algorithm), a physicist speaks about beauty of a physical theory, or a chemist about beauty of a designed molecule. Moreover, aesthetic methodology is utilized by scientists as an effective means to develop hypotheses and analyze data. It also prevents the researcher from going off in the wrong directions and even become a helpful tool for finding mistakes in the given result.[4]

In this regard, I would like to discuss the approach of Roald Hoffman (1990) to the beauty of a certain type of molecules; namely, $NaNb_3O_6$. This Nobel laureate in chemistry applied beauty for both modeling new molecules and assessing existing ones. Let us consider some general principles of Hoffmann's approach through the example of his description of the structure of the molecul $NaNb_3O_6$.

> The beauty of this aesthetic object resides in its structure, which is at once symmetrical and unsymmetrical. The beauty is in the incredible interplay of dimensionality. Think of it: two-dimensional slabs are assembled from infinite one-dimensional chains of edge-sharing octahedrals of oxygen around niobium, which in turn share vertices. These two-dimensional slabs interlink to the full three-dimensional structure by bonding with one-dimensional needles of niobium and sodium. And then, in a final twist of the molecular scenario, these one-dimensional needles pair up niobiums, declining to space equally. The $NaNb_3O_6$ structure self-assembles, in small black crystals, an aesthetic testimonial to the natural forces that shape the molecule, and to the beauty of the human mind and hands that unnaturally brought this structure into being. (p. 194)

Such an application of the beauty to a field of science is exceptional rather than common: scientists usually characterize beauty of artifacts in terms which, in themselves, are imprecise (such as elegance, grace, and the like). The beauty of nature of human behavior is characterized by much the same approach. Although highly credible, these single, disjointed observations on the aesthetic nature of non-artistic structures are unsystematic and delusive.[5]

If one follows my above offered definitions concerning aesthetics, their applications to science should be recognized as very limited because they mainly involve some general, fuzzy features of beauty and an aesthetic method. Unfortunately, scientists did not use explicitly a developed aesthetic method in a process of obtaining the result when they needed to choose between the approaches: to start from the beginning (in terms of Janus process) to avoid false moves and, finally, to find mistakes in a given result.

First and foremost, I intend to prove that the aesthetic method, when comprehended in its essence, can be just as effective in analyzing objects in non-artistic fields as it is in regard to work of art.

My second proposition concerns the linkage of aesthetics with feelings (in detail about the nature of feelings see chapter 4). Traditionally, the aesthetic method is tied to emotions and is commonly thought to be a prerogative of Man (and, sometimes, of highly intelligent animals) insofar as he is capable of producing art. That is why scholars have tried to locate the stable psychological and physiological bases of aesthetics. Individual human valuations, of course, have not thereby been ruled out. I think any object developing in time via stages which create predispositions, any interacting objects capable of being perceived aesthetically (and any object of the system so defined can act as subject), in any field, can use the aesthetic method while bypassing human involvement. Man still has to be there, of course, to analyze what's going on. But there is a big difference between man's direct aesthetic interaction with an object and the object's aesthetic development. Admittedly, the aesthetic method is, it seems to me, present especially in the development of new species in the internal mechanism of chance implanted in the genome of a cell,[6] in interactions between developing cells, in the formation of seemingly counterproductive intermediate genotypical and phenotypic structures (here associated with the concept of preadaptation), in the interactions of some particles on the subatomic level, etc.

Thus, I arrive at the notion that along with humans' aesthetic measurements (as well as all other sorts of measurements), the aesthetic method is utilized by various systems in the sense that, as these systems function, the objects themselves produce the measurements of aesthetic nature.

MACROSTRUCTURE OF THE AESTHETIC MEASURE

I want to make a general comment that precedes my analysis of aesthetic measurement by human beings—yes, we are making such a measurement. This measurement is not objective, but it exists. There is a measurement behind the intuitive, subjective sensory evaluations of a piece of art. Having accepted this point of view, I can understand the statement made by Gottfried Leibniz concerning music: “musica est exercitium arithmeticae occultum nescientis se numerare animi”—“music is practice hidden in mathematics, the spirit is not conscious that it is counting.”[7]

Characterizing an Aesthetic Object

In analyzing the particularities of beauty, I conclude that there is a certain core, a specific structure that is connected neither to sense perception nor to artistic devices. Despite the common view of beauty as a combination of the sensual and the artistic, to me, the structure of a predisposition is the heart of beauty. First and foremost, the category of predisposition is distinguished by the formation of such a structure of a state that allows further development. This structure requires the presentation via a set of essentials and positional parameters as independent variables and their corresponding evaluation in semiconditional values.

Although in characterizing beauty one usually emphasizes the role of sense perception of the object, in most of the cases the representation of the object's predisposition is implied. My first attempt to approach this latent structure was to cut off the sensual methods linked to the instrumental (pragmatic) assessment of an object. Hunger is the best example of the feelings agitated by one's pragmatic needs. Thus, I attempted to search for the sensual methods among objects with intrinsic values. In this process, such objects might be unique.

Let me explain this statement in the context of its phenomenological aspect. An architectually unique building perceived as beautiful may lose this value if surrounded by the same kind of buildings—and the whole system is then distinguished by a disharmonious relationship (poor relationships may be considered as a particular case of disharmony). As a result, this group of buildings may be perceived as ugly. Analogously, different buildings each of which is determined as unique and beautiful may also create a plain, unsightly group if related through disharmony. Thus, to be perceived as beautiful, a group of objects must display harmonious relationships between its constituent parts.

Minimally, the structure of an aesthetic object must be analyzed in order to penetrate the relationship between the sense perception and the object. Needless to say, an attempt to decompose the structure may result in the loss of its wholeness. That is why scholars have such a negative attitude toward the reductionism of the aesthetic perception; they try to avoid any type of indirect relationship between the object and its aesthetic sense perception.

At the same time, they clearly understand that a lack of cognitive analysis may hamper the aesthetic perception of an object, and that such a lack hinders the arousal of emotions connected to the cognitive assessment of that object. Indeed, any new artistic movement elaborates its manifesto through explanation of the new principles on which that movement is based. As the history of art indicates, the path to an audience's feelings often goes through their conceptual understanding of the innovations introduced by the artist. In other words, the cognitive process may alter and develop feelings, which are incapable of absorbation into beauty of the object.

"It seems clear to me, noted Roald Hoffman, that knowledge—of origins, causes, relations and utility—enhances pleasure. Perhaps that cognitive enhancement is greater in scientific perusal, but I would claim that it applies as well to a poem by Ezra Pound" (pp. 196-197).

Thus, the main problem is how to separate the formed unity into its constituent parts in order to synthesize the structures into a new, enriched wholeness encompassing sense perception.

The simplest way to such a separation was introduced by professional groups of people who worked with both the composed characteristics of an object and their subjective assessments. They concluded that the general values of the artistic object were based on the sum total of their assessed characteristics. Salvador Dali (1965) introduced such an approach to the analysis of an artistic object. Using a 20-point scale, he assigned the following characteristics to the piece: *technique, inspiration, color, subject, genius, composition, originality, mystery,* and *authenticity*. Dali made a comparative table of values of eleven renowned artists, including himself. Upon summation of the value of the assessments, first place was taken by Vermeer; he was followed by Raphael, Velasquez, da Vinci, Dali, Picasso, and Mondrian.

In analyzing specific features of Japanese art, Vsevolod Ovchinnikov (1971) emphasized some general characteristics inherent in Japanese vision of beauty. Though more concrete than those of Dali, Ovchinnikov's characteristics were vague and indistinct. Ovchinnikov noticed that the Japanese have introduced four concepts in the measurement of beauty: *sabi, wabi, sibui,* and *yugen*. *Sabi* characterizes oldness, naturalness manifested in the stamp of time on the object. *Wabi* is the absence of garishness, the wisdom of restraint. *Sibui* is a timeless quality of the traditional, a combination of sabi and wabi. *Yugen* is the mastery of suggestion, the charm of hidden insinuation. Working out the quantitative characteristics of these parameters belongs to the sphere of intuition.

One must admit that such a rough subjective evaluation of a work of art based on a small number of indistinct parameters does not allow one to find a strong and complete analytical description of an aesthetic structure. This makes it impossible to comprehend the essence of those deep relationships existing between the parameters of an aesthetic structure and its global values.

The structure of predisposition represented logically is supplemented by the artistic layer which is structured by various artistic devices inherent in literature, painting, music, theater, etc. The artistic devices can be created by means of sounds (rhymes, rhythms, etc.), words (allegories, metaphors, etc.), drawings, odor, and the like, and they, in turn, may directly influence our feelings.

Multistage Process of Forming Beauty

The process of development of beauty is multistage. Discussions with Vera Zubarev touched upon some interesting problems of a multistage process of creation. The category that I call *imagination* consists of different steps of human creativity at an informational level. The creation may start with *mess,* where various disjointed, fancy images dwell. Although these particular images may never materialize, they can be successfully represented at the informational level. This mess, then, may generate *fantasy*, the category distinguished by a certain degree of organization. Ultimately, a *representation*—orderly and complete image—evolves.[8]

The structure of creation beauty can be divided on three layers. The first layer is to delineate the primary layer, that, which I conventionally call the *logical*, and to determine the essential and positional parameters of an object as independent variables along with their conjugated (dual) parameters. The second layer is to delineate a layer, formed of artistic devices whose structure is isomorphic to the structure of the primary layer. The third layer is the establishment of mutual relationships between these two layers, on the one hand, and between these layers and sense perception, on the other hand.

The logical layer includes different objects created for one's *eventually* pragmatic needs: they suggest either purposes as closers or contain the idea of a certain direction to their development. In this layer, decisions can be made and conclusions absorbed both rationally/irrationally and intuitively/consciously. The structure of process of formation of these objects may be analyzed through predispositions, without employing artistic means and feelings. Exactly this method of analysis was exploited in previous chapters of this book in regard to the concept of predisposition introduced to the chess game, socioeconomic systems, and ethics.

The layer of artistic devices includes the world of art—the various fields in which the objects—formed and represented in different artistic languages (such as literary images, sounds, colors, and the like) are intended to influence one's images and feelings, not to be merely perceived.

Relationships between logical and artistic layers can sometimes be extremely whimsical. For instance, the material objects inherent in the logical layer can be considered from the point of view of the secondary layer. In other words, one can outline artistic devices forming these objects, which, in turn, can be linked directly to sense perception. So, Marcel Duchamp shocked the public in representing a urinal as a subject of art. His goal—to make the public refocus from the pragmatic characteristics of the primary layer of this object, and, instead, to consider its form as a subject of aesthetics—if accomplished, might have aroused sense perception.

The joining of the two layers becomes the main principle of applied art. On the contrary, *art for art* is nothing but the development of the second layer so as to ensure the evolution of the artistic means. In this sense, futurism is extremely indicative. A leader of this literary movement, the poet Alexander Kruchenykh (1967), stated that futurists sought to develop words creation in accordance with the "words' inner laws which might be understood only by the *speech creator*, and never follow the rules of logic or grammar" (p. 68).

Thus, the creative process can be represented as a chain of logical and artistic links intertwined whimsically along with the stages of development inside each layer. It is really unimportant in which of the layers the idea will be initiated. For instance, one can start developing intent in the logical layer, as was shown in chapter 5 through the example of the leader deciding on the strategic positioning of his company. This process of decision making can be analyzed through the structure of predispositions without reference to sense perception. At the same time, the formation of single components constituting the position of the company can be done intuitively.

Now, let us suppose that businessmen, whose decisions are mostly made in the logic layer, have to deal with artistic means in order to make their decisions. The involvement of the second layer may help to better understand the primary layer. In this sense, literature is a good resource for businessmen, for it can help them to intertwine, through marvelous examples, the logical and artistic levels. It can also provide them with a new method of decision making based on a total integration of sense perception and conceptualization.

Needless to say, in this turbulent world, businessmen appreciate most of all one's professionalism; this parameter becomes so crucial for them that they see no reason to spend time to obtain any other qualifications but those which increase their professional ability. Therefore, together with Vera Zubarev, I began to teach a course of decision making based on the conjunction of modern concepts inherent in this field (including mathematical models) and in works of art.

As we synthesize the primary and secondary layers, we may not only utilize the artistic means inherent in the secondary layer but also develop the secondary layer itself. In this connection, Vera Zubarev's book (1997) is quite interesting. Zubarev analyzes Chekhov's four major plays through their connection to implied mythological paradigms (she showed Chekhov's great interest in mythology and revealed some hidden applications to myths in his letters and early works). The mythological paradigms are reconstructed in Zubarev's analysis and synthesized on a new level into certain integrated structures. Thus, so called realistic artistic plots were brought to a new dimension and enriched by the comprehensive logic analysis.

In the light of this analysis, the scientific creative process may be considered as a chain in which artistic methodology may be included as an intermediate stage in the development of a hypothesis. Moreover, a scientist may be carried away by the development of artistic means so that he could drop his primary intention to follow this direction; he may even create the *complete incompleteness*—the main subject of art. This is especially true of distinguished scientists who often switch to the artistic field while working on their hypothesis (poetry, prose, paintings, etc.).

Consider also the correlation of the two layers, starting with the artistic and gradually coming to an enriched pragmatics through applied art. Designers and engineers combine art and pragmatics to produce utilitarian household appliances that attract consumers because of the artistic forms employed. Such technical aesthetics are not only used in consumer goods but also in constructing airplanes, submarines, machines, and the like.

Articles of common use
attract one by their artful design;
They successfully combine aesthetic nonsense
with pragmatic goals.
Therefore, they often serve as a good example
of how to achieve the desired
(Just as beauty can be taught by street girls).
—Ulea, *About Poetry*

AESTHETIC MEASURE AND QUALITY OF PRODUCTS

Beauty in its complete realization is a measurement of an object's predisposition to development, and that degree is expressed in artistic forms which include sensory perceptions.[9] Since this measurement is done during an interaction between the object and the subject, the development of subject can be also observed; at the same time, its predisposion to development increases. Importantly, some dead-end situations may appear: the artist (as subject) can be transmitted into the artisan if he fixates upon his method of creation as well as upon the objects to which that method is applied. At least he will limit himself by creating *variations of a certain theme*. To develop himself, the artist must, first of all, develop his method by either changing his previous method or by changing the variety of objects with which he works.

One should distinguish between evaluating the beauty and evaluating the quality a product. Although these processes seem to be analogous, they are developed through different additional parameters: in forming a predisposition as the basis of beauty one must add semiconditional values of positional parameters to the essentials estimated through semiconditional evaluation; in establishing hedonic prices for measurement of quality of a product one adds evaluations of additional essentials to the current price of the basic product (Katsenelinboigen, 1992*b*). For example, in studying hedonic prices for new autos attention was paid to changes in such material parameters as horsepower, weight, length, and whether the autos were hardtops or convertibles, had automatic transmissions, power steering, and power brakes.

As to the evaluation of predisposition, here we add to the essentials, which are estimated by semiconditional values, evaluations of positional parameters in analogous evaluations.

The analogous situation takes place in the measurement of the quality of capital goods (machines or their single parts, buildings, and the like). It is possible to measure the differences in such indicators of product quality as preciseness of manufacture, smoothness of surface, sturdiness, and the like. This value of these indicators can be measured in accordance with their influence on the pragmatic value of the product. Such sort evaluations cannot be easily taken from statistics (especially from the point of view of their influence on the pragmatic value of a product), and one must resort to the expert's evaluations.

While combining evaluations of predisposition and quality of a product, one can experience a certain methodological difficulty with regard to their connection to utility. In accordance with the extreme view of the nature of aesthetics, evaluations of a predisposition and quality must be completely abstracted from utility. That view is invalid in the case when utility is considered but one of the components of the predisposition, not as its crucial parameter.

Roald Hoffman (1990) writes in regard to this: “Much philosophic tradition would object to including the utilitarian perspective as an aesthetic criterion.... Here I would only add the empirical testimony of the practitioners—be they deluded, naive or not—chemists really do think that *use* is an element, not the most important one, but an element of chemical beauty” (pp. 201-202).

It seems to me that such permission to inject utility into the holy aesthetic world as a part of its structure allows one to more deeply understand the relationship between these two categories. In turn, it may enrich aesthetics itself, for the utilitarian structures accepted as gestalts may carry within themselves very rich relationships.

Some works (e.g. Rapaille, 1995) state that evaluation of the product's quality consists not only of its functional (pragmatic) and aesthetic quality (appearance), but it also includes the so-called emotional quality stipulated by the relationships between the customer and provider.

Thus, the general quality of a product can be characterized as a predisposition which includes along with essentials (functional quality) and a group of positional parameters concerning the relations between the customer and the product (aesthetic quality as an appearance of the product) also another group of positional parameters concerning the relationships between the customer and the provider of the product.

BIRKHOFF'S APPROACH TO THE AESTHETIC MEASURE

Birkhoff's Formula of the Aesthetic Measure

In accordance with Edmund Whittaker (1945), the well-known American mathematician George Birkhoff set as his goal the creation of "a general mathematical theory of the fine arts, which would do for aesthetics what had been achieved in another philosophical subject, logic, by the symbolisms of Boole, Peano, and Russell." At a 1928 conference in Bologna, Birkhoff first introduced his approach to the aesthetic measure; he later developed the concept in his book (1933).[10]

Although Birkhoff did not realize his dream in full measure, we owe much to his effort. His works in this field are among the first attempts to conceptualize the analysis of the object of art, an analysis that was followed by the decomposition of structures. In his analysis, Birkhoff highlighted a specific structure that, in accordance with my definition, may be called *predisposition*.

As Birkhoff (1956*a*) noted:

> The typical aesthetic experience may be regarded as compounded of three successive phases: (1) a preliminary effort of attention, which is necessary for the act of perception, and which increases in proportion to what we shall call the complexity (C) of the object; (2) the feeling of value or aesthetic measure (M) which rewards this effort; and finally (3) a realization that the object is characterized by a certain harmony, symmetry, or order (O), more or less concealed, which seems necessary to the aesthetic effect. (pp. 2185-2186)

Insofar as initial parameters included by Birkhoff in the aesthetic measure: Birkhoff strongly distinguished between the parameters of *complexity* and *order*. To illustrate, Birkhoff uses the example of a convex polygonal tile. The

measure of its complexity is determined by the number of its sides; the measure of order, by such parameters as repetition, similarity, contrast, equality, symmetry, balance, and sequence. Such an approach to the aesthetic measure fully correlates to the category of predisposition considered in my analysis: the essentials (analogous to complexity) and positional parameters (analogous to order) were chosen accordingly as independent variables.

Researching the analytical structure of the aesthetic measure which corresponds to the parameters of complexity and order, Birkhoff measured those values directly through sensations, omitting their rational evaluations. In accordance with the scheme proposed by Birkhoff (its weaknesses can be neglected for the current analysis), a measure of sensations from a physiological/psychological point of view is accomplished through the development of a sort of tension.

Hence the value of *complexity* denoted with a C was formally expressed as C = ra+sb+tc+..., where a, b, and c are indices of tension, which the nervous system must create so that the essential parameters can be perceived, and which take place r, s, and t times. These feelings have a negative sign because "the fact that interest of some kind is almost necessary for sustained attention."

A value for order denoted with a O is O = ul+vm+wn+..., where l, m, and n are indices of tones of feelings repeated u, v, and w times. Feelings may be positive, negative, or neutral. Repetition, similarity, contrast, etc. produce positive feelings, while ambiguity, undue repetition, and unnecessary imperfection produce clearly negative feelings.

After the publication of Birkhoff's formulae for the measurement of beauty, others attempted to find within this formulae a strong psychological (McWhinnie, 1968) and neurophysiological basis of perception (Rashevsky, 1960). There have been recent notable achievements in research on the neurophysiological basis of aesthetic measures. The presentations at seven conferences of the Studiengruppe Biologishe Grundlagen der Aesthti (held at the Werner-Reimers-Stiftung, Bad Homburg von der Hone, Germany) are especially interesting; they became the basis for a book edited by Ingo Rentshler, Barbara Herzberger, and Dana Epstein (1988). An analysis of these materials is beyond this book.

By factoring *feelings* into the creative process, and beauty in particular, one may increase one's creativity and also utilize the evolutionary biological experience in the evaluation of different objects (feelings comprise the evolutionary experience of evaluation). Often feelings coincide with cognitive evaluations, especially when one needs to evaluate the dynamic parameters of an object. Dynamic parameters include: the search for innovation (the feeling of curiosity); and an unexpected positive result instead of the expected negative one (the feeling of excitement). However, as mentioned in chapter 4, those feelings generated within a certain natural environment may not always fit into the new artificial environments created by man.

Hence, it becomes necessary to create a *cognitive* concept that can contain both the structure of initial parameters inherent in beauty (as Birkhoff did) and the formation of their dual parameters (evaluations).

Objective and Subjective Evaluations of an Aesthetic Predisposition

In this connection, a fundamental question arises: Does beauty exist objectively within an object? Yes, it does, if the object develops *from inside* and goes through the stage of predisposition. From an external point of view, the answer derives from a subjective evaluation of one object by another during their interaction. At this point, a general recognition of the objective evaluation of an object's beauty cannot be formulated: all that can be said is that the majority of subjective evaluations of the object as beautiful coincide. The fact that there still exists a different evaluation of the object seems to be important for its future development: diverse opinions among a small group of people may, at least, prevent the object from passing into oblivion, and as the history of mankind attests, even endure the elaboration of new criteria for evaluation.

Let us now consider on the microlevel, the question of the possibility that the universalization of certain parameters can objectivize beauty. It seems to me that the answer to this question can be given positively, especially in regard to the essentials.

The essentials always existed in the structure of beauty, often in paintings (the dotted dabs on the paintings of Georges Seurat). These initial elements exist in archetypes as more developed forms. Accordingly to *The New Encyclopedia Britannica,* the term *archetype* was adapted "from the writings of the psychologist Carl Jung, who formulated a theory of a 'collective unconscious.' For Jung, the varieties of human experience have somehow been genetically coded and transferred to successive generations. Originating in pre-logical thought, these primordial image patterns and situations evoke startlingly similar feelings in both reader and author."

The idea of archetypes penetrates not only psychology but also natural science. In the work by Hoffmann (1990), to which I frequently refer in the book, much is said concerning the matter of the usage of archetypes in building molecules (pp. 199-200).

One may assume that values of different archetypes relate not only to physiology and psychology, but to the dominant culture in any given field. I would not propose a certain method of determining the values of these archetypes; however, to make an analogy to chess, I assume that these values are semiconditional and can be obtained in accordance with accepted in art rules of interaction between archetypes.

Presumably, deep differences between peoples' evaluations of parameters determine a predisposition reflect primarily positional parameters (as in a chess).

In art, where the essentials are represented by units smaller than those in chess, the role of positional parameters in the formation of predispositions is crucial. Traditionally, the role of positional parameters in art is emphasized, while essentials are barely considered. Such an attitude is understandable, as in cases where a plethora of objects, whose essentials are the same, are differentiated exclusively through their diverse relationships. Supposedly, Plato's ideal forms reflected extreme conditions from which essentials were excluded and the emphasis was placed upon positional parameters.

In a chess game, the positional parameter of the closeness of two pawns reflects their function that is characterized from the point of view of their potential for mutual support; the concrete magnitude of the semiconditional value of this parameter is based on the chess player's subjective evaluation. Analogously, with regard to positional parameters in art, cognitive methods to elaborate assessments provide clarification concerning the function of positional parameters and then their subjective evaluation.

In regard to the total cognitive evaluation of beauty, it is extremely important that, when creating it, the values of the essentials and positional parameters must be semiconditional.

To confirm this statement, consider the concepts of *divine* and *diabolic* beauty, notions encountered in aesthetics. Obviously, moral evaluations of one's behavior becomes the bases for these two definitions of beauty. As was shown in chapter 4, a moral evaluation is based on unconditional values. This observation can be applied to an evaluation of Robin Hood's behavior.

Indeed, many of his features are attractive (his personality, attitude toward the members of his group, and struggle for justice). Thus, Robin Hood's behavior seems to possess divine beauty. However, his violation of moral restrictions "Though shalt not murder" must be evaluated negatively; and these, when considered in combination with some highly positive evaluations of his intent, place him firmly in the realm of diabolic beauty (diabolic alludes to the means).

Correlation Between Complexity and Order

The integration of complexit*y* and order in Birkhoff's work presents a special interest. The aesthetic measure denoted as M is a ratio of the two previously defined variables O and C: M = O|C.

As Birkhoff contended, such a formulation allowed one to see the following: the aesthetic measure is a ratio, a proportion, and that the higher the complexity, is the lower the significance of the aesthetic measure becomes (other things being equal).

It was so important for Birkhoff to prove that the value of the aesthetic measurement is represented by the ratio of these two variables that he even looked at the analogy between his aesthetic formula and economics, saying that, for business enterprises of a single definite type success is determined by the ratio of profits to investments. However, it seems to me, that this analogy is not quite correct.

Significantly, in economics relationships between profit and investment are considered not only for business enterprises of a single definite type but also for a comparison of effectiveness of activity of any business enterprises. However, differences and likenesses of business enterprise is not the only point here. In economics, the opposition between investments and profit is based on the following fact: investment reflects frozen means while profit represents current flows of values.

A measurement of the effectiveness of a business enterprise may be limited to profit if investments are intended exclusively for purchasing non-durable

ingredients which are used during one extremely short (relatively to the time sacrificed to forming investments for future profit) cycle.

The analogy to the profit is adequate for the aesthetic measure if it is limited by essentials. Indeed, profit juxtaposes cost and benefit only in frames of essential parameters; positional parameters are not included in profit. In profit essential parameters may have, accordingly, positive and negative signs. In regard to the aesthetic measure, the comparison to profit would mean only the comparison of cost and benefit (concerning parameters of complexity). However, according to Birkhoff, all the complexity parameters—essential parameters—have only a negative valuation. I agree that essential parameters, to be perceived as information signals, require an expenditure of nervous energy and that these expenditures could have a negative sign. I also favor the view that, having passed through our nervous system, these signals agitate the nervous centers that could first produce totally positive feelings. That is why, even for the essential parameters of a reasonable work of art there is a balance of negative and positive feelings with a predominantly balance on the account in favor of positive feelings.

At the same time the comparison to economics can be extended if one takes into account the fact that the position of a company (its predisposition to further development) includes—along with essentials—positional parameters. As was shown in chapter 5, these positional parameters may have both positive and negative values. In the aesthetic measure described by Birkhoff, parameters of order may be considered as analogous to positional parameters; furthermore, Birkhoff assumes that they may have different sign of evaluations. A more complete analogy between economics and aesthetics can be made if parameters of complexity and order (with the corresponding negative/positive values) are included in the aesthetic measure. Here we speak of the analogy in essence, for in both cases we are dealing with the measurement of value of a structure possessing a predisposition to development.

The analogy above originally occur during my consideration of an analogy between the formalized position in a chess game and the formalized position of a company. In analyzing the structure of a chess game, I understood the role of the positional style in comparison with the combinational, the role of positional parameters (along with essentials) as independent variables and the necessity to introduce to the analysis a whole spectrum of values for the different degrees of conditionality. This also helped me to conceptualize the chess game itself.

The analogy between the behavior of a company and the progress of a chess game seemed natural in the sense that, in both cases, the competition of the participants and the achievements of their final goals in the process when “the time is out of joint” seemed to have the same nature. Later, when I became familiar with Birkhoff's works on aesthetics, I was amazed by the similarity of the formal structures of chess position, position of a company, an aesthetic measure. Although cursory examination revealed little in common among these three structures, deeper consideration showed them to be surprisingly similar. But, needless to say, the issue is not the simple assertion of the formal similarity of these structures.

From the history of sciences, we know that the homogeneity of mathematical formulae can be used as a pretext for pronouncing a hypothesis on the homogeneity of the phenomena concealed behind them. Just that sort of phenomenon took place in the nineteenth century when James Maxwell, on the basis of the discovered homogeneity of the differential equations describing wave forms of electric, magnetic and light energy demonstrated their common nature.

Starting with an understanding of these mathematics, I began to search for a common structure beyond those formalisms which appeared independently during the first 30 to 50 years of the twentieth century. I found that in this case we dealt with predispositions—the structures which are not completely and consistently linked to pragmatic goals but, at the same time, are somehow organized. Thus, I assumed that in the light of the contemporary view of a chess game and a company's behavior, it might be beneficial to search for an analogy between the criterion used to evaluate a position in chess, a company's strategic position and an aesthetic measure.

Let us return to Birkhoff's formula for aesthetic measure: M = O|C. In accordance with this formula as applied to an evaluation of work of art, the simpler the structure and the better it is organized, the higher its aesthetic measure becomes. It is a quite popular aesthetic concept that also makes sense if considered in regard to logical structures in which a fixed result may be realized by decreasing the numbers of premises (Occam's razor).

However, if one wants to achieve a more definite result, a greater number of premises may be needed. If one assumes that the goal of art is to form predispositions for perpetual development, then the value of essentials as well as the method of their organization via the positional parameters must correspond to the creation of the proper conditions for the development of a predisposition. At this point, a smaller value of essentials (even if they are perfectly organized) results in decreasing the possibilities of further development.

Presumably, such assertions are dictated by our intuition that resists the acceptance of Birkhoff's formula for aesthetic measure. For instance, suppose we have two works of art of the same type. The first has a greater value of essentials than the other—a higher value of C—and it is also better organized—a higher value of 0. At the same time, the proportion between C and O inherent in both objects is the same. Thus, if one were to follow the Birkhoff formula for aesthetic measure, it might turn out that a more complex and more organized object will possess the same aesthetic measure as a more simple and less well organized one.

One may posit another aesthetic concept: the more sophisticated and the better organized the object of art, the higher its aesthetic measure will be. This concept was briefly mentioned above, and I have made some arguments in its favor. In such cases, Birkhoff's formula for aesthetic measure can be transformed into linear form, such as M = O+C or, as it is mentioned in (Eysenck & Castle, 1970), M = OxC.

This last formulation absorbs Birkhoff's concept. Let us take as an example the abstract art that, in Birkhoff's terms, is primarily distinguished by a small

degree of complexity coupled with high order. For instance, the abstract paintings of Piet Mondrian, complexities of parallel and perpendicular lines, may be interpreted either as a part of another painting (for instance, as a painting of a house with some pictures on the wall) or (another perspective) as an enlarged part of a non-abstract painting. This example should help the reader comprehend how the relatively simple may be immersed into the more complex. Surprisingly, Michail Shemiakin applied such techniques to some of his paintings, making a delightful synthesis of some motifs of Russian folklore with the abstract structures inherent in Wassily Kandinsky's pictures.

The question arises: is it possible to assume, based on a formula M = O+C, that paintings with a greater number of essentials will be perceived as more attractive—in terms of aesthetics—than paintings with a smaller number of essentials but with a greater value for positional parameters of order? The answer is "no," if the aesthetic measure will include along with essentials a sufficient number of positional parameters with their correspondent evaluations. The analogous situation was described in chapter 2 in regard to the comparative evaluation of chess positions with different numbers of pieces (essentials) and different positional parameters.

In art, the works of a modern Spanish architect, Antonio Gaudi (1982) may serve as a good example. Gaudi's style has come to be called *equilibrated*. His main work, The Church of the Sagrado Familia in Barcelona (only partly implemented), is described in the *Britannica* article concerning Gaudi: "he equilibrated the cathedral-Gothic style beyond recognition into a complexity symbolic forest of helicoidal piers, hyperboloid vaults and sidewalls, and hyperbolic paraboloid roof."

At first sight, Gaudi's buildings seems overwhelmed by whimsical geometrical forms combined with bas-reliefs. They may seem ugly, especially when compared to functional architecture. However, thorough analysis reveals the richness of both the essentials and positional parameters which suggest the possibility of further development.

I experienced the same feelings while comparing the simple and elegant shrines of Shinto in Japan with the ornate Buddhist temples, veneered in reflective mosaic tiles, found in Thailand (especially Bangkok).

Roald Hoffmann (1990) expressed a point of view very close to mine:

> Complexity poses problems in any aesthetic, that of the visual arts and music as well as chemistry. There are times when the *Zeitgeist* seems to crave fussy detail—Victorian times, the rococo. Such periods alternate with ones in which the plain is valued. Deep down the complex and the simple coexist and reinforce each other. Thus the classic purity of a Greek temple was set off by sculptural friezes, the pediments, and the statues inside. The clean lines and functional simplicity of Bauhaus or Scandinavian furniture owe much to the clever complexity of the materials and the way they are joined. Elliott Carter's musical compositions may seem difficult to listen to but their separate instrumental parts follow a clear line.

> In science simplicity and complexity always coexist. The world of real phenomena is intricate, the underlying principles simpler if not as simple as our naive minds imagine them to be. But perhaps chemistry. the central science, is different. for in it complexity is centrals I call it simply richness, the realm of the possible.
>
> Chemistry is the science of molecules and their transformations. It is the science not so much of the hundred elements, but of the infinite variety of molecules that may be built from them. You want it simple...? We've got it for you. You want it complex.... (p.197)

Thus, as the evolution of organic, inorganic and social worlds elucidate, growing complexity is a predominate tendency of development; complex objects which are well organized create a greater predisposition for development and are highly influential in regard to this process. This does not deny the possibility for the formation of objects with simple aesthetic structures. Significantly, objects with complex aesthetic structures may often absorb those with simple aesthetic structures; but it cannot be vice versa.

Algorithmization and Verification of Aesthetic Measure

In closing my analysis of Birkhoff's formula for aesthetic measure, I note some attempts were made to create an algorithm for its calculus. Attempts to define such an algorithm utilized ideas of organizing (not programming) procedures of measurement of beauty by establishing a sequence of steps designed to reveal and quantify the state of a system's structure at successive stages.

In the general case, the hierarchy of the aesthetic measure can be built when the characteristics of the condition of the aesthetic construction is based upon a sufficient multitude of initial parameters and their evaluations. On the basis of these gestalts the next level of gestalts and their relationships is built. Even some prime elements in the art of the abstractionists were simplest gestalts with discernible figurative structures. The evolution of Wassily Kandinsky, a founder of abstract painting, reveals the artist's striving to discover a certain composition of previously discovered basic elements. It was expressed in gestalts' possessing the simplest biological forms (e.g. a fish) along with more amorphic structures. It was precisely the search for these combinations that characterized the last, Parisian period of the great painter's life.

All this makes the problem of the evaluation of conditions of objects much more sophisticated since it must be correlated with the creation of a hierarchy of gestalts and their relationships, including all corresponding evaluations of these components.

In the work by George Stiny and James Gips (1978) the algorithmization of the aesthetic measure is represented in a relatively simple way. In the process, not all the parameters inherent in the states of structures—especially their evaluations—were objectified. They might have been formed subjectively by those who did the measuring.

The algorithm of measurement proposed by the authors was most fully illustrated through the examples taken from Birkhoff's works. As to the algorithmic measurement in paintings (particularly, through the analysis of Velaskes' "Weavers," [Las Hilanderas]), music (through the example of Shenrer's theory of tonality) and literature (through the analysis of Vladimir Propp's Russian fairytales), the most valuable conclusions are dependent upon the authors' penetration into the states of structure. The structure included essentials and positional parameters but their evaluations were not considered by the authors.

Finally, in speaking of the development of the idea of the aesthetic measure proposed by Birkhoff, I must note that many authors did not limit themselves to creating theory; attempts were made to experimentally verify their ideas (Smets, 1973). There even appeared the experimental psychology of beauty (Valentine, 1962). But they tried to determine experimentally the advantages of a concept of beauty based on the simplicity and symmetry of its aesthetic elements in comparison with the concept of beauty based on complexity and asymmetry.

Meanwhile, Frank Barron (1952), experimentally comparing artists' and non-artists' attitude toward complexity and asymmetry in regard to geometrical figures and paintings, came to the conclusion that the former prefer complexity and asymmetry rather than simplicity and symmetry.

In summary, this chapter revealed the universality of an aesthetic method that can be applied to any system with or without the regard of human feeling. Beauty as a central structure of this method can be analyzed; in other words, it can be decomposed and recreated.

On the macrolevel, a logical formed predisposition takes part of the heart of beauty. A developed form of beauty is based upon a predisposition represented through artistic means which arouse feelings.

Functionally, beauty is directed toward creating a predisposition to a system's development. Such kind of understanding of beauty allows one to create aesthetic methods as a chain process. In these chain processes of logical strata overlaid by topological and artistic means, serve to arouse feelings which become predispositions of artistic layers; in turn, artistic works, pragmatically considered, become subjects of applied art, and, while losing their purely artistic identification, turn into bare logical predispositions— reminiscent of the characteristics of science.

On the microlevel, a great contribution to the aesthetic measure was made by George Birkhoff. Expanding his concepts, one can say that, with regard to human perception, the kernel of beauty is represented through the essentials and positional parameters and values of these parameters measured by feelings refracted through cognitive evaluations. One may assume that the richer is the set of the essentials and the positional parameters including composites of different layers, the more beautiful the object is for people that can properly evaluate these parameters.

NOTES

1. As the young poetess Caroline Storm said in one of her unpublished poems "You leap into the world of uncertainty with the belt of beauty around your waist."

2. Such an approach to aesthetics is very common. Thus, in a book by George Stiny and James Gips (1978), "*Aesthetics* is concerned with questions about how existing works of art can be described, interpreted, and evaluated and with questions about how new works of art can be created." (p. 1)

3. A methodological approach based on disjointed Janus processes (see chapter I) may help one to discover some new aspects of that old category called aesthetics.

4. The late Professor Boris Moishenzon, a distinguished mathematician and scientist, was well known as one of the most experienced mathematicians who was able to find mistakes in proofs of theorems developed by his colleagues. As he told me, his search for errors was accompanied by finding *ugly points* in the proof of a theorem. Unfortunately, his premature death did not allow us to conceptualize his intuitive search for those ugly points.

5. Judith Wechsler (1988) mentioned: "the role of aesthetic judgment is rarely mentioned in the corpus of science and mathematics" (p. 1).

6. In my 1997 book, I attempted to show that changeability in the course of the evolutionary process may be influenced by more than the occasional impacts of the environment on the structure of DNA. I proposed a concept of the mechanism of inner changeability inherent in the genome. The development of molecular biology more and more confirms my hypothesis. I tried to link the mechanism of inner changeability with a Janus process which can be started both from the *end* (under the influence of requirements dictated by the experience of interaction with the external environment) and from the *beginning* (formation of predispositions). The latter is especially important for cases when changeability is complex, as it is in decoding the principle of the functioning of a new specimen. I applied all these speculations to the concept of variety of genders understood as functionally distinguished reproductive cells participating directly in the reproductive process. I came to the conclusion that the Janus process from the beginning is first of all a characteristic of female cells. Here I made an impossible hypothesis that these cells are more developed than others and have more possibilities in the complex process of changeability (exactly through female cells is the non-Mendelian heredity realized). All this is reflected in the cells' genome and the mechanism of its inner changeability.

I keep saying that these speculations are the result of the natural philosophy, which has been partly confirmed by modern molecular biology. I decided to publish them, assuming that the modern methods of molecular biology are very powerful, even though, in research, classic biological concepts dominate. It is quite possible that my impossible hypotheses will help to unchain the dominant basis of modern biological concepts and engender some productive ways for their development.

7. Quoted from Patrice Bailhache (1992)**.**

8. Although the sleep generates mess, it, nevertheless, may achieve the level of representation (the solving of tasks during sleep).

9. The expression "measuring immeasurable" (or its paraphrases), that is relevant to measure beauty, was widely used (the HotBot on the World Wide Web keeps under this expression a file of 433 sources) as in relation to art (e.g., Louis Kahn, 1986), as to other fields, in particular to religion (e.g., Thomas O'Neil, 1980). Meanwhile, this was mainly an aphorism and has not been broadly and deeply developed.

10. I will risk expressing some speculative thoughts in this matter. It is known that George Birkhoff was a founder of the matematical theory of dynamic systems. He probably thought about such states of a system in which it becomes impossible to conju-

gate the states of an object, while relying exclusively on such general characteristics as coordinates and speed. Supposedly, Birkhoff understood the necessity to introduce incomplete linkages between the states via essentials and various relationships. It would be very interesting to research Birkhoff's works on dynamic systems, applying his ideas of aesthetics.

CONCLUSION

In this book I have separated the notion of indeterminism from other philosophical categories, especially from uncertainty. In defining indeterminism as *eluctability* and seeking its degree, I considered determinism, accordingly, as an extreme case of evitability, namely—*ineluctability*.

A multidimensional systems approach to the category of indeterminism assumes various aspects: functional, structural, methods of operation, the role of the operator, and genesis.

Here I would like to focus on such indeterministic phenomenon as aesthetics. As mentioned in the Introduction to this book, this category is insufficiently developed, a condition which seems to retard the development of other relatively unexplored fields of knowledge that are based on protracted systems notable for the disjointed linkages of their extant states. Importantly, such systems, though in a state of non-equilibrium, nevertheless possess a certain level of order. We can find examples in such fields as artificial intelligence, social and economic systems, ethics, and even theology (interpretations of the Torah).

I believe that the reason for the insufficient development of aesthetics lies in its application to such a complex system as art. The complexity of the artistic system is defined in this book as the organic intertwining via feelings of both logical and artistic layers while in other systems (from chess to theology) the logic layer assumes dominance.

Meanwhile, the method of a frontal attack of complex systems is not always in effect. To analyze a complex system one should immerse it into a larger system, a suprasystem, which consists of various systems with differing degrees of complexity. In this book, various protracted systems with disjointed linkages of their states were utilized. To separate the general features of the phenomenon from its specific features, one should search for isomorphism in the suprasystem. The next step is to integrate the isomorphism's along with specific features of a given system.

Thus, I divided the process of analyzing the aesthetics into three steps: first, I considered the simplest manifestations of the aesthetic method in a relatively simple system—chess, social and economic systems (the logical layer); then, I researched its more complex manifestations in ethics, in combining cognitive and sensual evaluations within the logical layer; and, finally, I referred to art where the two layers, the logical and the artistic, are intertwined via feelings.

All other indeterministic methods are considered in this book mostly with regard to their connection to the aesthetic method and its specific features.

Thus, based on systems approach, I came to the following conclusions regarding the aesthetic method.

Functionally, the aesthetic method is directed toward forming connections between the states of a system. The states are represented through the notion of their beauty, that is, through predispositions as such, which, in the ideal case, are not influenced by the boundary conditions of the whole system (art for art)**.** Although such kinds of constructs as predispositions do not have a pragmatic purpose, they are still somehow organized.

In this connection, Immanuel Kant's famous expression that beauty is a "*purposiveness without purpose*" (*Zweeckmassigkeit ohne Zweck*) implies, on the one hand, the evaluation of an object that is somehow organized (purposivenness); on the other hand, it emphasizes the lack of any means to allow a pragmatic assessment (without purpose).

The comparison between Kant's and my definitions of beauty will help one to make the following conclusion (except the one concerning the author's immodesty). The functional definition of the category highlights stages of its development: from the formulation of the initial question to the final stage which allows one to introduce a degree of its development. As I see it, in comparison with Kant's general definition of beauty, I made an essential step forward in regard to its degree, namely—I determined the structure of the "purposiveness without purpose" in introducing independent variables and their evaluations through the spectrum of unconditional values. This allowed me to define the degree of beauty as a degree of predisposition of a system to its development. Thus, I specified the abstract notion of the "purposiveness without purpose": I proposed a way of counting of the degree of beauty through structuralization of the essentials and positional parameters as independent variables and their unconditional evaluation.

Thus, in the functional context, the aesthetic method as applied to the most developed kind of art is a result of development of other simpler methods directed to the formation of predispositions. Importantly, such predispositions treat of intermediate, not self-sufficient, structures, but they are under some influence of the boundary conditions of the system to which they belong. The latter, as I showed in chapters 2-5, may be observed in their simpler manifestation in chess, and then—in more complex states—in social and economic systems.

This *structural* approach to the aesthetic method links, first of all, the analysis (decomposition) of the object of the aesthetic measure to its subsequent synthesis. As I showed with regard to the formation of predispositions in the logic layer, this decomposition can be made (in a simple case) through highlighting

the essential and positional parameters as independent variables and their semi-conditional values. The representation of a state via essentials and positional parameters is not sufficient for a predisposition if these parameters are evaluated in conditional values. Such a situation can happen in social systems via a programming method of its performance.

The parameters included in a predisposition of a certain system (chess, social systems, and the like) and their valuations are established as cognitively, as intuitively. In various systems (such as chess and economics) the valuations of the material parameters can be even objectified.

In the artistic layer, this situation gets more complex since there appear various additional artistic devices (all kinds of metaphors, allegories, rhymes, rhythms, and the like) through which the predisposition is represented. Besides their direct influence on the enrichment of the thinking process, they also arouse corresponding feelings which, in turn, continue to influence and enrich the thought process.

In order to show that there is a continuum rather than an abyss between the two layers, I created an intermediate layer, a topological (geometrical) interlayer. This interlayer carries both the power of the logical layer and picturesqueness of the artistic layer. Logic is clearly represented in algebraic topology and analytical geometry where the verbal and the geometrical are in a complete accord; the picturesqueness helps to develop logical notions through the brain structures connected to depiction. Moreover, the topological depiction itself may become self-sufficient as its artistic image develops. In other words, it takes the part of a predisposition in its artistic hypostasis.

The above is typical for Johannes Kepler's method of creation as analyzed by I. Bernard Cohen (1985) in a very original way. Kepler, after receiving from Tycho Brahe precise information about the planets' positions with respect to time, attempted to define their orbits. Nicholas Copernicus' and Tycho Brahe's concepts of the circular movement of planets were not effective in this matter. To find new formulae for the planets' movements, a certain aesthetic structure was needed.[1] Kepler, who revolutionized the notion of planetary movement, worked in the Platonic-Pythagorean tradition. In accordance with this tradition, the order of objects had been evaluated utilizing the notion of beauty, which was based on strong mathematical (both geometrical and analytical) concepts.

Kepler based his theory on the Greeks' geometrical concepts, which stated that there were five regular solids: the tetrahedron, cube, octahedron, dodecahedron, and iciahedron. Further, in inserting one geometrical figure into another in an elegant way, Kepler accommodated the notion of the six known planets. As a result, he discovered three laws of planetary movement.

Kepler's third law concerns harmonics—the connection between the planets' movement and musical structures (musical notes for tunes as defined by the harmonics of planetary motion). It was the Pythagorean idea of the Music of the Spheres: the notion that cosmic objects made musical sounds while rotating and that the distance between spheres and the not sounded were established in accordance with musical intervals. The Music of the Spheres—from Pythagoras to Kepler and Newton, Bach to Beethoven, and on into the twentieth century of

Einstein, Schönberg, Stravinsky, Cage, and Glass—is a spellbinding examination of the interwoven fates of science and music throughout history. The parallel histories of music and science—from celestial harmony to cosmic dissonance—is very well described in the book by the music critic Jamie James (1993).[2]

Thus, if in the logical layer the predisposition is represented as a scheme (either verbally or topological), then in the artistic layer it appears as the artistic image. However, the level of concentration of the image may vary. In speculating about the difference between poetry and prose, Vera Zubarev came to the conclusion that poetic devices such as rhythm, rhyme, etc. may be inherent in both genres. The difference between poetry and prose lies in a different degree of concentration of the image developing the artistic predisposition. That is why some authors intuitively called their prosaic (in a traditional sense) works poetry and vice versa. For instance, *Dead Souls*, the famous novel by Gogol, was not incidentally subtitled a poem by the author; inversely, a poem *Eugene Onegin* by Pushkin was subtitled a novel in verses.

> Hence, a rhymed work can be called prose
> And a non-rhymed work may be called poetry
> They differ just as birds
> Differ from poultry.
>
> —Ulea, *About Poetry*

In applying this analogy to solving tasks of a greater dimension, one can see that the artistic representation of the object is based on a greater number of parameters in comparison with its abstract logical representation (both methods are at the same level of generalization). The question arises: how to overcome the problem of dimension?

In mathematics, the procedures of composition and decomposition were elaborated. Presumably, the power of artistic mastery lies in the artist's ability to find a proper level for both the composition and concentration of artistic means which, in comparison with its logical representation on the same level of composition, will allow the artist to increase the power of expressiveness of a predisposition. In other words, the same expressiveness created both by logical and artistic means can be anyway achieved more effectively and economically in the latter case. In poetry this concentration of artistic methods to create imagery is the greatest.

The next aspect of the systems approach to the aesthetic method concerns *processing*. This approach helps to create methods to define the boundaries of an object's states. I propose to outline three large groups of such methods, each distinguished by their different degree of completeness: spontaneity, predispositioning (i.e., development through predispositions) and programming. In predispositioning, states of a system are differentiated depending upon the degree of their completeness; in programming, a continuum is created which links an object's states.

One can build a matrix uniting structural and processing aspects: by simplification, this matrix allows one to see a great diversity of artistic and scientific

genres. The methods of bounding an object's states (spontaneity, predispositioning, and programming) are on the one side of this matrix. Each method may have a different degree of importance when combining with the two other methods. Ranked in accordance with the degree of their importance, these methods create 3! combinations, that is, six possible variants to each combination.

Another component of the matrix is composed of the forms of representation of the states (logical, topological, and artistic). Arranged in accordance with their importance, these forms also give us 3! combinations. Again, I denote a certain number of six possible variants to each combination. As a result, we receive 36 variations among the combinations of the methods of correlation of the states and forms of their representation.

Let me now present a more extended picture of these combinations, which I propose to call "The Initial Steps Inherent in the Code of Creation." A 6-digit number in each cell shall designate the extended number of each of the 36 combinations. In the virtue of its cumbersomeness, I will not introduce its graphic representation. Only some examples from the table formed of the cells will be considered—first of all, the ones which may seem the least possible.

Thus, the cell 123321 might represent Pollock's abstract paintings. As is known, Pollock created his paintings in accordance with his concept of life as a set of occasional events. So, he represented his concept through a manifold spontaneous splashing of colors along the canvas. Hence spontaneity is the basic method for Pollock (1). The next level of importance seems to be taken by predispositioning (2), since Pollock assumed that the role of the artist is to correct, just a little, this spontaneous picture. This technique was applied by Pollock to his paintings. Obviously, programming (3) did not play a major role in Pollock's concept. In regard to the dimension inherent in representations of the states, first place is occupied by artistic forms (3), then a small degree of topology (2) comes, which is followed by a very small degree of logical means (1).

Cell 132123 can be represented by the mathematical method Monte-Carlo. Here the method for correlating states is based on spontaneity (1) while the states are linked via programming (3). Predispositioning is practically absent. Representations of states are made, first of all, through logic (1), then topology (2), and the artistic (3) method is barely discernible.

Cell 231123 includes the chess game. Here the dominant role belongs to predispositioning (positional style [2], followed by programming (combinational style, the library of debuts [3]), and, in some cases, by spontaneity (this method may be used to move from debut to the creation of a position in cases where the common technique of switching needs to be changed (1). Logical representation (1) of states is dominant; however, there is still some suggestion of topological (2) and artistic (3) states.

Cell 231312 may be characteristic of John Baldessari's (1972) paintings. The artist writes a certain text on the canvas in accordance with which the viewer can create his own picture.[3] Here we see the predominate role of predispositioning (2), not only for the text itself but also for its environment—the canvas, the atmosphere of painting, and so on—which can be considered as developing a predisposition. Programming (3) and spontaneity (1) are less

important to this method. The state of an object is represented, first of all, through artistic devices (the written text can be considered as an artistic work [3]); then the logical (1) and topological (2) are given less important roles.

Cell 231231 may be occupied by Johannes Kepler's concepts as described above. The abstract expressionistic pictures by Wassily Kandinsky and supramatistic pictures by Kazimir Malevich can be put in cell 321321, though the power of the topological forms used by these painters differs, Kandinsky's is closer to the artistic.

Let us now consider the *operator's* approach. I would like to outline three particular features: numbers of operators, the subjectivity inherent in evaluation and realization, and the physiology of realization of this combination.

During our discussions concerning the difference between artistic and non-artistic work, Vera Zubarev suggested that artistic work is distinguished by the figure of the narrator (in prose)/lyrical hero (in poetry). In some cases they may coincide with the author, in other cases there can be a great distance between them. However, no matter how close or remote they are from the author, their presence in a work is distinguished by an integrated vision provided through a hidden personality, unlike the situation in a non-artistic work where in the integrated vision is provided exclusively through the narrator's idea. As Zubarev states, the degree of the author's artistic mastery depends, first of all, on the author's ability to create that integrated character of narrator/lyrical hero.

I propose to call this narrator *the third operator*. The core of the aesthetic method (in its developed case) lies in the presence of three operators combined into the notion of an *artistic operator*. The three operators are: the author, the narrator and the spectator (in the broad sense of this word). Obviously, in science we deal with only two operators—the author and the spectator.

In regard to the evaluation of a system's state and its realization: in predispositioning, the evaluation of predisposition is made subjectively, for it cannot be separated from the operator. Objectivity may be inherent in programming and spontaneity—which means that these methods presuppose a gap between the evaluator and operator.

We now consider the physiology of the operator's work. The operator can be either *vertical* or *horizontal*. In this work I am mostly concerned with vertical operators represented, primarily, by people. A horizontal operator is present when the rules of cooperation work as such; for example, the *invisible hand* in an economic system. Another example is the brain. In accordance with the modern understanding of brain function, the two hemispheres, left and right, participate in the creative process. The former is responsible for logic, the latter, for images and feelings. Hence, the creative process can be roughly represented as an iterative interaction of the two hemispheres.

Another perspective is connected to the category of conscious/unconscious (intuitive). One should take into account that the intuitive process can occur in both hemispheres. The formation of the creative result can be thus described: a vague idea starts in the left hemisphere which then consciously begins developing logical premises. Next, the information so created is transmitted to the right hemisphere where the problem is resolved intuitively—through artistic images

representing beauty in its developed stage (and those feelings generated by it). The decision obtained during this process is transferred to the left hemisphere where it is going to be refined (first unconsciously and then consciously). The creative process can be initiated in the right hemisphere either consciously (under the influence of exterior factors) or unconsciously (under the influence of interior factors) and then transmitted to the left hemisphere for its processing (both unconscious and conscious); that concept can then be returned to the right hemisphere for further intuitive development, and so on.

Unfortunately, my simplified presentation of the creative process cannot compete with Henri Poincaré's (1952) brilliant description of the mechanism of a creative process in mathematics involving beauty and feelings. However, a lack of knowledge of the operator's two brain hemispheres allow Poincaré, at that time, to consider this process only within the framework of conscious/unconscious.

It seems to me that Poincaré's concepts can be reconsidered in the light of contemporary understanding of the brain—left and right hemispheres, on the one hand, and conscious and unconscious, on the other.[4]

The last perspective of the systems approach to the aesthetic method is *genesis*. Genesis reveals the history of consecutive and parallel appearances of logical, topological and artistic representations of an object's states, and utilizes different methods for their correlation. There is an enormous amount of literature concerning this matter.

NOTES

1. In this connection, I remember my discussion with Herbert Simon in the mid-80s after his lecture in the University of Pennsylvania concerning his elaboration of the computer program BAKON (Simon, 1982). Given limited data on the distances of the planets from the Sun, this program automatically rediscovered Kepler's third law. I asked Simon if Kepler could have done the same in working with a much larger data base. He answered negatively. Simon, if I understood him correctly, agreed that in order to attack huge data base, one must have a preliminary hypothesis which, presumably, belongs to the realm of aesthetics.

2. From the point of view of the evolution of analytical concepts, their transformation into topological ones and then into artistic ones, the drawings by Anatoly Fomenko are of interest; they illustrate some problems in homotopic topology developed by Anatoly Fomenko, Dmitry Fuchs, and Victor Gutenmacher (1986).

3. John Baldessari characterized his approach to painting as follows:

> What This Painting Aims to Do? It is only when you have been painting for quite some time that you will begin to realize that your compositions seem to lack importance—that you are to ordinary.
>
> That is when you will start to break all the so-called rules of composition and think in terms of design.
>
> Then you can distort shapes, invent forms, and be on your way toward being a creative artist.

This quotation has been taken from John Baldessari's early 90s exhibition at the Whitney Museum of American Art (New York).

4. The book by Jacques Hadamard (1996), that is completely based on Henri Poincaré's 1908 presentation of his ideas on the creative process in mathematics, is relevant to this matter.

GLOSSARY

Aim - purpose that is completely and consistently linked with the previous as well as the subsequent following stages
Attractors (repulsors) - *see* Dual parameters
Beauty - the value of a predisposition
Combinational style - well defined narrow material goal and a program of execution
Conditional values - *see* Positional price
Conjugate parameters - *see* Dual parameters
Determinism - *inevitability* of the events
Dual parameters - valuations
Essentials - parameters that constitute the skeleton of a state
Ethic - a metaconcept to form the spectrum of social valuations of the degree of conditionality
Fully conditional values - based on complete and consistent link of all the pre-conditions which define a given state
Fully unconditional values - none of the preconditions for fully conditional values is satisfied
Goal - purpose that is completely and consistently linked with the previous stage and linked incompletely and inconsistently with subsequent stage
Ideal - unachievable stage
Indeterminism - *avoidability* of the events
Initial parameters - the set of essentials and positional parameters
Janus process - a process where the changes in the system are triggered both at the *end* and at the *beginning*
Material parameters - *see* Essentials
Mess - a set of unrelated objects
Moral - set of unconditional and semiunconditional social values
Objectivity - allows to separate the observer and the executor
Positional parameters - relations between essentials

Positional price - a semiunconditional valuation of an essential combined with the semiunconditional valuation of positional parameters attached to the given essential

Glossary

Positional style - creation of predisposition
Predisposition - a state that is predisposed to development in the unknown future
Price - global dual parameter of the economic field
Primary parameters - basic parameters versus agregated
Relational parameters - *see* Positional parameters
Semiconditional valuation - takes into account only certain parts of the preconditions for fully conditional values
Semiunconditional values - based on complete and consistent link among the rules of interactions
Strategic positional style - a plan where the purposes of each stage is expressed via positional parameters
Subjectivity - impossibility to separate the observer and the executor
Unconditional valuations - based on fully unconditional valuations but with a positive or a negative sign

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